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Mosaic disease of Sugar-cane.—*Louisiana Planter*, lxix, 25, pp. 442–443, 1922.

In the report of the Committee in charge of the Experiment Station of the Hawaiian Sugar Planters' Association for the year ending 30th September, 1922, Lyon gives an account of the investigations of mosaic disease carried on during the year by Kunkel.

The latter found mosaic on several cultivated Gramineae, including maize, sorghum, and Sudan, Tunis, Guatemala, and Wonder Forage grasses, and also on the common wild goose grass [*Eleusine indica*] and bristly foxtail grass [*? Setaria*]. Experiments resulted in the actual transference of the disease from Sudan grass to sugar-cane and to bristly foxtail grass, while there is strong evidence that the disease has been transferred from sugar-cane to both maize and sorghum. In his experiments on the transference of the disease from one sugar-cane plant to another and from other plants to sugar-cane, Kunkel has found only one natural agent of transmission, namely the maize aphis [*Aphis maidis*]. The latter does not feed on the sugar-cane by choice, but thrives on all the other cultivated grasses mentioned above. Mosaic disease in the cane fields can therefore be greatly restricted by limiting the cultivation of susceptible grasses in their vicinity and by the elimination of the wild grasses liable to infection. Any measures directed against the maize aphis should likewise tend to control the spread of the disease. Kunkel's experiments have also shown that the mosaic of sugar-cane can be transmitted by inoculation from diseased to healthy plants. Quite recently he has demonstrated the presence of foreign intracellular bodies in the diseased tissues of mosaic cane similar to those which he previously discovered in maize [see this *Review*, i, p. 194], Chinese cabbage [*Brassica chinensis*], and *Hippeastrum*. These are believed to represent a stage in the life-history of the agent causing the disease. In the sugar-cane they are to be found in necrotic areas only a short distance below the growing point, and they become obscured at an early stage in the development of

the cane tissues through the breaking down of the cells in which they lie. They cannot, therefore, be demonstrated in the older tissues.

In recent experiments Kunkel has found that when very young leaves of diseased cane are exposed to bright sunlight, through the removal of the older leaves, they develop a solid green colour and show no signs of mosaic. Presumably the sun's rays destroy the causative agent. The partial recovery of old leaves when exposed to the light is well known, and experiments to test the effect of exposure to X-rays are in progress.

It was definitely proved by a series of experiments on four different plantations that none of the standard canes grown in Hawaii can produce maximum results while infected with mosaic disease. The loss in sugar production due to this disease is very great. The following control measures, in addition to those mentioned above, are recommended: the use of seed cane from healthy plants; the destruction of diseased canes; the use of resistant varieties where the surrounding area cannot be freed from the disease; the propagation of seedlings resistant to, or immune from, the disease; and the prevention by quarantine measures of the introduction into Hawaii of other insects likely to act as agents of transmission.

BÜREN (G. v.). **Weitere Untersuchungen über die Entwicklungsgeschichte und Biologie der Protomycetaceen.** [Further investigations on the life-history and biology of the Protomycetaceae.]—*Beiträge zur Kryptogamenflora der Schweiz*, v, 3, 94 pp., 2 pl. (1 col.), 27 figs., 1922.

This important work is divided into four sections, dealing respectively with the forms of the genus *Protomyces* inhabiting the Umbelliferae; those inhabiting the Compositae; the genus *Protomycopsis*; and the genus *Volkartia*.

In the species occurring on Umbelliferae, morphological observations and a series of experiments resulted in the establishment of seven 'formae speciales' of *Protomyces macrosporus*, namely: f. spp. *aegopolii, heraclei, chaerophylli, charrefolii, carvi, ligustici*, and *laserpitii*. The 'collective host' for *P. macrosporus* is the parsnip, *Pastinaca sativa*. In cross-inoculation experiments, f. sp. *aegopolii* was transmitted to *Carum, Selinum, Angelica*, and *Laserpitium latifolium*: f. sp. *heraclei* to *Laserpitium latifolium* and *L. siler*, and f. sp. *ligustici* also to *L. latifolium*. The f. sp. *laserpitii* infects *Peucedanum* and *Thapsia*. Neither the collective nor the secondary hosts were found to be infected under natural conditions in the neighbourhood, presumably on account of a deficiency of moisture in their habitat.

In the case of the Compositae, specialization is much stricter than in the forms inhabiting the Umbelliferae. There is no record of any form of *Protomyces* on a genus of the Compositae being transferred to another genus of the same family. Only the form occurring on *Crepis biennis* (*P. crepidicola*) appears to have a few secondary hosts within the genus *Crepis* (*C. aurea* and *C. pontana*). The latter were very mildly attacked and infection was probably only rendered possible by the favourable conditions prevailing

during the experiment. The following species of *Protomyces* occurring on the Compositae were studied: *P. pachydermus* on *Taraxacum officinale*; *P. kreuthensis* on *Aposeris foetida*; *P. krieger*ianus n. sp. on *Leontodon hispidus*; *P. picridis* n. sp. on *Picris hieracioides*; *P. crepidicola* n. sp. on *Crepis biennis*; and *P. crepidis-paludosae* n. sp. on *Crepis paludosa*.

Various morphological differences, such as the dimensions and colour of the spores and shape of the sporangium, characterize the species of *Protomyces* parasitic on the Compositae. The only certain means of identification, however, is the observation of germinating chlamydospores.

The investigation of the genus *Protomycopsis* presents considerable difficulties owing to the low germination percentage of the resting spores. Four species of the genus were studied. *P. chrysanthemi* n. sp. attacks *Chrysanthemum alpinum* in damp places on the mountains, causing the formation of whitish-yellow, flat callosities, mostly on the under side of the leaves, but occasionally also on the pedicel. The resting spores are formed terminally on the mycelial ramifications within the leaf parenchyma, and the vascular bundles are free from the fungus. The membrane of the young chlamydospore is covered with small warts, and in profile also exhibits a ring of extremely fine rod-shaped structures in the thickness of the wall. Both these features are absent from the mature chlamydospores, and there is nothing to distinguish a *Protomycopsis* resting spore from that of *Protomyces* except the thicker membrane of the former. The diameter of the chlamydospores ranges from 28·5 to 46·5 μ (average 36 to 37 μ) and the pale buff-coloured membrane is 4·5 μ thick. The sporangia measure 55 to 60 by about 50 μ. *Protomycopsis leucanthemi* was found capable of infecting only *Chrysanthemum leucanthemum*, though the experiments were few in number. A form which is referred to the same species was also found on *C. atratum*. Cross inoculations showed that *P. leontodontis* n. sp. is transmissible from *Leontodontis autumnalis* (on which it was found) to *L. montanus*, while *P. arnoldii*, collected on *L. montanus*, infected *L. autumnalis*, though in a very mild degree.

In 1916 the author showed (*Mitt. naturforsch. Gesellsch. Bern*, pp. 112–124. 1917) that *Volkartia* is perennial in the underground portions of its hosts, whence it annually renews its attacks on the young shoots. Subsequent experiments with *Volkartia umbelliferarum* on *Heracleum sphondylium* showed that the mycelium also invades the floral organs; it can penetrate the pollen sacs and cause degeneration of the pollen grains, and it also enters the ovules, sometimes reaching the embryo sac and checking the development of the embryo.

The author concludes by a short discussion of the systematic position of *Volkartia*, in which he expresses a doubt regarding the separation of this genus from *Tuphridium*. Of the two species, *V. umbelliferarum* and *V. rhactica*, hitherto described, the latter (and possibly also the former) agrees with *Tuphridium* in the mode of spore formation, earlier accounts of the process having been based on incorrect observations. He expresses himself as being in entire agreement with Juel that the series of the Hemiascaceae:

Protomyces, *Protomycopsis*, and *Volkartia-Taphridium*, leads directly to the Exoascaceae (*Taphrina*).

MASON (F. A.). **Micro-organisms in the leather industries. III. Species of the genus Penicillium and their identification (contd.).**—*Bull. Bureau of Bio-Technology* (Murphy & Son, Ltd., Sheen Lane, London), 6, pp. 161–175, 5 figs., 1922.

Of the four species of *Penicillium* named by the author in his previous paper [see this *Review*, i, p. 44] only two, *P. expansum* and *P. decumbens*, are found at all frequently on leather, the last being the more common. They belong, respectively, to the *Eupenicillium* and *Aspergilloides* groups, so that they can be readily distinguished.

P. expansum is found much more frequently on old de-natured leather, such as worn-out boots and leather scraps, than on newly tanned articles; in the author's experience, skin, limed pelts, and fancy leathers are free from it. Tan liquors contain the mould in a small amount, and it develops slowly in tanning extracts prepared from valonia and quebracho; it has not been met with in the dust of these substances. On old leather it occurs usually in bright blue, velvety spots up to 1 cm. in diameter, the colour being darkest in the centre and shading off to white at the edges.

P. decumbens has been found on all kinds of leather, including both vegetable and chrome tanned goods, on limed pelts, and on sheepskins from the soaks. Its effect is to obliterate the grain, the rather large, effused, indeterminate colonies spreading rapidly. Its appearance differs with age; the first effect resembles a stain, but later on a woolly appearance develops as the spot turns greyish-green. Ultimately it becomes a dark green, velvety patch, without any white boundary zone. On tanning materials the fungus occurs frequently, having been isolated from the dust of sumach, valonia, and quebracho; in the green scum from the tan liquors it was found to be the dominant organism.

P. lanosum was found on leather as a secondary organism in conjunction with *Aspergillus luchuensis*. It grows in small, grey-green colonies, at first rather similar to those of *P. expansum*; but the subsequent production of long, aerial filaments gives it a much more woolly appearance. It was not found on tanning materials, but grew slowly on valonia and quebracho extracts, with a darkening effect on the liquid.

P. viridicatum has not been recorded on leather, but was isolated by the author from a mixture of organisms collected from a tan liquor. Growth was slow in valonia and quebracho extracts, the liquids becoming darker in colour and a dark brown precipitate being formed.

A table giving morphological data (from cultures on wort agar) for the identification of the four species of *Penicillium* referred to is appended.

FROMME (F. D.) & WINGARD (S. A.). **Blackfire or angular leaf spot of Tobacco.**—*Virginia Agric. Exper. Stat. Tech. Bull.* 25, 43 pp., 2 col. pl., 18 figs., 1922.

The blackfire disease of tobacco caused by *Bacterium angulatum*

is prevalent in almost all the tobacco-growing sections of Virginia, a survey conducted in 1920 revealing its presence in 85 per cent. of the fields. Blackfire and wildfire (*Bacterium tabacum*) both occur in the seed-bed, the former being found in 70 per cent. of the beds inspected during three seasons, and the latter in only 13 per cent.

The causal organism of blackfire is seed borne, and seedling infection may usually be traced to the use of contaminated seed or plant-bed cloth, on which also the pathogen may overwinter. Tobacco refuse and, to some extent, the soil, are further sources of infection. Raindrops are the chief means of dissemination, and excessive rainfall also predisposes the plants to disease by inducing a succulent and vigorous growth. The most rapid spread is during the period of most rapid growth of the host, and the greatest injury is caused to the most vigorous plants. The use of phosphatic fertilizers indirectly promotes severe infection by increasing the size and vigour of the plants. The difference in severity of infection at the different heights of topping is also very marked, plants topped at a height of eight to eleven leaves being more susceptible than those topped at a height of twelve to fourteen leaves. These observations are believed to indicate that the pathogenicity of the organism is closely related to the metabolism of its host. All the varieties of tobacco grown in Virginia are susceptible to the disease, and none of the eight tested in 1919 showed a sufficient degree of resistance to promise effective control by varietal selection. So far no evidence has been found that *B. angulatum* can attack any other plant but tobacco. Seed disinfection by soaking in a 2 to 2½ per cent. formaldehyde solution for fifteen minutes or 1 in 1,000 corrosive sublimate for ten minutes has given very satisfactory results as regards control of the disease, but the former treatment slightly impedes germination. As soon as the crop is harvested, the ground should be ploughed to suppress the further growth of the plants and prevent the accumulation of infective material.

WEBER (ANNA). **Tomatsygdomme.** [Tomato diseases.]—66 pp., 3 pl. Copenhagen, N.C. Rom., 1922.

The principal diseases of tomatoes are enumerated, together with a brief account of the symptoms, effects, and distribution of the more important, and appropriate measures of control. The list of diseases due to fungi, bacteria, and physiological conditions includes the following: Potato blight (*Phytophthora infestans*), foot rot (*P. cryptogea*), buck-eye rot (*P. terrestris*) [*P. parasitica*], *Sclerotium* blight (*Sclerotinia sclerotiorum* and *Sclerotium rolfsii*), *Phoma* fruit rot (*Phoma destructiva*), canker (*Diplodina lycopersici*), leaf blight (*Septoria lycopersici*), anthracnose (*Colletotrichum phomoides*), stem-end rot (*Botrytis* sp.), wilt or sleepy disease (*Verticillium albo-atrum*), rust (*Cladosporium fulvum*), *Macrosporium* rot (*Macrosporium tomato*; *M. solani*), *Fusarium* wilt (*F. lycopersici*), *Rhizopus* fruit rot (*R. nigricans*), and diseases caused by *Pythium de Baryanum*, *Rhizoctonia* (*Hypochnus*) *solani*, *R.* sp., *Verticillium lycopersici*, *Isaria clonostachoides*, *Melanconium* sp., *Fumago vagans*, *Fusarium erubescens*, *F. orthoceras*, *F. oxysporum*, *F. sulphureum*, *F.* sp., *Puccinia pittieriana*, *Synchytrium endobioticum*, and *Spongospora subterranea*.

Of bacterial diseases the following are mentioned: bacterial spot (*Bacterium exitiosum*), Grand Rapids disease (*Aplanobacter michiganense*), streak (*Bacillus lathyri*), and bacterial wilt (*Bac. solanacearum*).

Of the above the following have been observed in Denmark: *Phytophthora infestans*, *Sclerotinia sclerotiorum*, *Sclerotium rolfsii*, *Diplodina lycopersici*, *Septoria lycopersici* (not serious), *Botrytis* sp. and *Verticillium albo-atrum* (both noticed for the first time in the summer of 1922), *Cladosporium fulvum*, *Macrosporium solani* (of no economic importance), *Phytophthora cryptogea*, *Fusarium sulphureum*, *Hypochnus solani*, and *Bacillus lathyri*. Reports of the occurrence of *Bacillus solanacearum* are probably due to a confusion with *B. lathyri*.

Mosaic, leaf roll, blossom-end rot, hollow stem, cracking of unripe fruit, and green bark, which are regarded as diseases of physiological or unknown origin, have all been observed in Denmark. There is a table for the identification and treatment of the chief diseases, and a bibliography of 113 titles is appended.

Badoux (H.). **Ennemis du pin Weymouth.** [Enemies of the Weymouth Pine.]—*Journ. forest. suisse*, lxiii, 6, pp. 101–104. 1922. [Abs. in *Monthly Bull. Agric. Intell. and Plant Diseases*, xiii, 7, p. 919, 1922.]

Cenangium abietis, which usually occurs on various conifers as a simple saprophyte, has been known to cause serious, and even fatal, damage to pines of all ages from five years upwards. Between 1914 and 1918 *C. abietis* attacked the white or Weymouth pine [*Pinus strobus*] in several parts of Switzerland (Zürichberg, Horgen, and Rothenburg), and in 1921 it occurred in a closely packed stand of sixty-year-old pines on alluvium in the Hinterholz forest. The diseased trees died off from the top downwards within a radius of 100 acres. The infected wood was found to be very brittle, while the blackish discoloration rendered it unfit for commercial purposes. Of the 587 c.m. felled in 1921 only 90 c.m. could be utilized in building, &c. The stand has been thoroughly cleared to prevent the spread of the attack.

C. abietis also occurred as a parasite in 1921 in Pomerania [see this *Review*, i, p. 332].

Rands (R. D.). **Streepkanker van Kaneel, veroorzakt door Phytophthora cinnamomi n. sp.** [Stripe canker of Cinnamon caused by *Phytophthora cinnamomi* n. sp.]—*Meded. Inst. voor Plantenziekten*, 54, 53 pp., 6 pl. (1 col.), 1922. [English summary].

The present paper deals with the author's recent field and laboratory investigations of a bark canker of cinnamon (*Cinnamomum burmanni*) trees in the uplands of the west coast of Sumatra, which for some years past has caused considerable losses. The disease is particularly severe in badly drained inland plantations where the trees are set far apart and interplanted with other crops. In seven such plantations examined the estimated percentage of disease varied from 1 to 42, and it may even reach 90 in certain cases. Its economic importance cannot be readily assessed, since the canker

is frequently accompanied by insect attacks. Susceptible trees succumb to the combined effects of the fungous and insect parasites within a year after attack, and generally before they attain the most profitable age for harvesting.

The most striking symptom of the disease is an irregular vertical stripe of dead bark, 1 to 5 cm. in width, originating at or below soil level and reaching sometimes to a height of 10 to 15 m. The stripe is deeply depressed, and often bounded by callus at its base, and is thus more conspicuous than higher up on the trunk. The normal greyish-white colour of the bark remains unchanged, except at the rapidly advancing upper extremity of the canker, on the surface of which drops of an amber or wine-coloured exudate, which soon hardens, appear. On susceptible trees the lateral growth of an active root canker sometimes produces fresh infections, which extend vertically close to the original stripe. On scraping off the outer layers of the diseased bark, it will be seen that the phelloderm, which is dark brown or red in colour, is sharply divided from the adjacent healthy tissues by a narrow black line, irregular and curving in the outer bark and nearly straight in the inner. The middle and inner layers of bark exhibit, at regular intervals of about a centimetre throughout the length of the canker, a succession of zones (generally fifteen to twenty-five) separated by thin layers of brown, gummed tissue. Rapidly spreading cankers were found to extend about 1 cm. daily and to develop one new zone each day. The secretion of gum apparently begins at night. Zonation was equally well marked under conditions in which the material differences between day and night, as regards temperature, light, and air, were eliminated, and also in cankers isolated from the rest of the tree. The rhythmic spread of the fungus is, therefore, probably correlated with some habitual periodicity in the physiological processes of the tree.

A species of *Phytophthora* has been repeatedly isolated from the margins of spreading cankers, and has invariably reproduced the typical symptoms of the disease on inoculation into healthy trees. It is believed to be capable of life in the soil. Two distinct strains from widely separated localities on the west coast were compared, and a consistent difference in their relative virulence observed. The more virulent strain produced cankers one-third longer on an average than the less virulent. Negative results followed the inoculation of *Erythrina lithosperma*, *Theobroma cacao*, *Hevea brasiliensis*, and *Carica papaya* with pure cultures of the more virulent strain. Conversely the species of *Phytophthora* occurring on the first three of these plants failed to produce appreciable lesions on *Cinnamomum burmanni*. The cinnamon *Phytophthora* is thus apparently strictly limited in its parasitism and distinct from other oriental species. On *Cinnamomum zeylanicum*, *C. camphora*, *C. culilawan*, and *C. sintok* the inoculations resulted in very slight infection.

The characters of the fungus in the host tissues are not described. No fructifications were observed either in nature or in the ordinary culture media, except chlamydospores. Conidia were, however, obtained in profusion by the following special method. An eight to ten-day old pea-juice culture was emptied into a sterile Petri dish,

the peas removed, the culture fluid drained off, and the mycelium washed for four to six hours in three changes of sterile water. The culture was allowed to stand in the last water for twelve to twenty-four hours, after which the water was drained off and only enough fresh added just to cover the mycelium. After another twenty-four hours thousands of conidia were found on the surface. They were of the usual *Phytophthora* type, except that they exhibited the phenomenon of internal proliferation similar to that which is found in *Saprolegnia*, but only known previously in a single species of *Phytophthora* [*P. cryptogea*].

The following diagnosis of the fungus is given. *Phytophthora cinnamomi* n. sp. Irregular, sparingly ramified, inter- and intracellular mycelium permeating bark and outermost layers of wood; occasional chlamydospores in the tissues; aerial hyphae on oat agar, hyaline, slender, 5 to 7 μ in diameter, later thick-walled and septate; haustoria not observed. Chlamydospores thin-walled, globose to pyriform, mostly 31 to 50 μ in diameter (average 41 μ), terminal on short lateral branches, abundant in artificial cultures, often in grape-like clusters of three to ten, germinating by three to eleven germ-tubes. Conidiophores undifferentiated, simple or sympodially branched. Conidia terminal, ovoid to ellipsoid or elongated, hyaline, thin-walled, with a broad, flat papilla on the end opposite point of attachment, mostly 38 to 84 by 27 to 39 μ (average 57 by 33 μ); later conidia produced on branches of the conidiophores in successive sympodial fashion and also by internal proliferation; wall of the conidium partially collapsing after discharge; conidia germinate in water by liberation of zoospores or occasionally by a germ-tube or the formation of secondary conidia. Zoospores bean- or kidney-shaped, with two flagella of unequal length attached to concave side; about 11 by 18 μ while swimming and 10 to 11 μ in diameter when at rest; germinating after about an hour by a germ-tube. Oospores not observed.

The control of the disease can be effected to some extent by the prevention of wounding and the maintenance of good soil drainage. These conditions are most nearly realized at present in the so-called 'forest cultivation', where the trees are closely planted on steep, rocky soil, and not continually wounded by the tillage of intercrops or by grazing stock. The trees are not susceptible to canker before the age of two to three years, during which period intercrops may be cultivated if desired. In the vicinity of farms or villages the wounding of exposed roots by animals is almost inevitable, and the planting of cinnamon trees in such localities should be discontinued.

The results of experiments in the control of the disease by excising the diseased tissues and applying hot coal-tar, 'Papco' (consisting of asphalt dissolved in carbon disulphide), or a paraffin-solignum solution, showed that the last-named effectually prevented further extension of the cankers, but caused severe injuries to the cambium. There is reason to believe that washing the wounds with a disinfectant before applying coal-tar or 'Papco' would promote the efficacy of these preparations. For the present, simple excision of diseased tissues, the harvesting of affected trees, and the improvement of general sanitary conditions on the lines indicated above, are recommended.

SUNDARARAMAN (S.). **A new Ginger disease in Godavari district.** —*Mem. Dept. Agric. India*, Bot. Ser., xi, 9, pp. 209–217, 4 pl. (2 col.), 1922.

During the heavy rainfall in August 1920, ginger crops in the Godavari district, India, were attacked by a leaf disease which spread rapidly and caused considerable damage.

The first symptom of the disease was the appearance of light yellow, round and oval spots, 2 to 3 mm. in diameter, on both the upper and lower surfaces of the leaves. Some of the spots coalesced, forming large, discoloured patches with minute, black dots in the centre, where the tissue afterwards dried up and fell out, leaving a hole. In the final stages, minute, dark dots appeared in irregular, concentric rings in the diseased region. These dots consisted of the stromata of a fungus, with large clusters of hyphae and masses of spores and setae. When the central shoots are affected the entire surface may be studded with these dots. The edges of affected leaves roll up and the tips bend and droop down. In very severe cases the petioles and the scaly leaves on the rhizomes are attacked.

The disease appears to be favoured by wind and damp, close weather subsequent to heavy rainfall. The rain washes the spores to lower portions of the plant, and the wind carries them from leaf to leaf and from plant to plant. With the return of dry weather many plants recover. The practice of close planting indirectly favours the disease by the exclusion of light and air.

The fungus was identified as a *Vermicularia* for which the name *V. zingiberae* n. sp. is proposed. The sporodochia are in dense clusters, circular or oval, 50 to 140 μ in diameter, and provided with numerous erect, dark brown, septate setae, 85 to 168 μ in length. The spores are subfusoid, curved, with blunt ends, hyaline, guttulate, and 17·5 to 24 by 3·1 to 4·2 μ. Chlamydospores [appressoria] of the *Colletotrichum* type are formed on the germ-tubes. It differs from the species of this genus that attack chillies and turmeric in India in the measurements of the sporodochia and the formation of chlamydospores, but is otherwise very similar to these forms. Cross-inoculations on chillies and turmeric gave negative results. The parasitism of *V. zingiberae* was definitely proved by repeated inoculations from pure cultures in the laboratory. Typical disease symptoms are produced in fifteen days when the inoculated plants are kept under humid conditions, but if kept dry infection does not result.

Spraying with Bordeaux mixture (5–5–50), first when the disease was fairly distributed and again six weeks later, increased the value of the yield by Rs 160 per acre.

GIBSON (F.). **Sunburn and aphid injury of Soybeans and Cowpeas.**—*Arizona Agric. Exper. Stat. Tech. Bull.* 2, pp. 41–46, 2 pl., 1 fig., 1922.

During the autumn of 1920 the writer observed a spotting of the leaves of cowpeas and soy-beans near Mesa, Arizona. Investigations carried out in the following spring showed the injury to be due to sunburn and aphid attacks, succeeded by infection with a species of *Alternaria*. The symptoms of sunburn and aphid injury

were similar, namely the appearance of brick-red spots which enlarged, turned brown in the centre, and later were often covered with a sooty black growth of *Alternaria*. The fungus, which is briefly described and for which the name *A. atrans* n. sp. is suggested, was weakly parasitic, growing in needle puncture inoculations in healthy plants, in leaves punctured by aphids, and in sunburned areas.

Loss of leaves in the Virginia soy-bean is very severe, and seriously diminishes the value of the plant for purposes of green manure, cover, and forage. Biloxi appears to be the most resistant variety. The other varieties attacked were Otootan, Barchet, Shanghai, Tokio, and Peking soy-beans and Blackeye cowpea.

BEWLEY (W. F.). **Anthracnose of the Cucumber under glass.**—*Journ. Min. Agric.*, xxix, 5, pp. 469-472 and 6, pp. 558-562, 1922.

The anthracnose of cucumbers caused by *Colletotrichum oligochaetum* Cav. is at the present time the most important leaf spot disease of the cucumber in England, and is responsible for heavy losses each year to the growers. In former years *Cercospora melonis* [*Corynespora melonis*] caused great destruction in the Lea Valley, but the introduction of the immune variety Butcher's Disease Resister, in 1903, together with improved methods of soil sterilization, led to its ultimate elimination. At present it is found only in isolated parts of the country.

The symptoms of anthracnose are briefly described. Isolation of the causal organism is easy, and it has been cultivated on a wide range of artificial media. Investigations made by the author showed that *C. oligochaetum* can live as a saprophyte on decayed woodwork, timber, paper, and other organic matter in the glasshouse, and is thus able to tide over the winter period. A further important source of infection has been proved to be the straw manure from the houses and also manure coming from towns, which is doubtless infected from diseased fruit discarded from street stalls and the like. In no case was the fungus found in stable manure fresh from the country.

Infected glasshouses should be cleaned by thoroughly spraying the interior woodwork with an emulsion of cresylic acid and potash soft soap, the formula for preparing which is given. High-power spraying machines should be used and the ventilators must be closed after the spraying in order to retain the strong vapours. A fortnight after the treatment, the houses may be replanted, but as a final precaution every cavity in the woodwork should be filled with putty and painted over. During the growing season the disease may be controlled by spraying the plants at weekly intervals with solutions of liver of sulphur or lime-sulphur, to which flour paste is added as a 'spreader'. Four formulae for the preparation of the spraying liquids are given and recommended as having been tested in commercial nurseries with satisfactory results. To be quite effective they should be used in the early stages of the disease before the fungus has attacked the leaf-stalk and stem tissues. On the following day after spraying every spotted leaf should be removed and burnt. Dusting with sulphur has been extensively

tested, but it has never been found to control the disease completely.

Good cultural methods and thorough (even drastic) ventilation of the glasshouse go a long way towards preventing or controlling the disease.

ANDERSON (P. J.). **Development and pathogenesis of the Onion smut fungus.**—*Mass. Agric. Exper. Stat. Tech. Bull.* 4, 34 pp., 6 figs., 1921 [1922].

Since 1918 the author has conducted an investigation of onion smut (*Urocystis cepulae*), the most destructive of all onion diseases in New England, primarily with a view to discovering effective control measures. This necessitated an exhaustive study of the life-history of the causal organism, the results of which are given in the present paper.

Laboratory tests showed that mature fresh spores germinate in onion decoction, sugar solutions, and various agars, but not in tap, distilled, or soil water. The presence of the onion or any substance derived therefrom is not necessary to germination, but sugar is apparently one of the most important stimulants. Freezing does not hasten or increase germination, but this effect is produced to a marked degree by free access of air and also by a period of rest in damp soil. When seedlings with unopened lesions were buried in sterile soil, mycelium of the fungus grew out freely into the soil, but whether it came from spores or from the vegetative hyphae in the tissues was not ascertained. Spores frozen in the ground are not killed. In the soil the spores become progressively prepared for germination; a few begin to germinate in three to six days under favourable conditions, and others germinate from time to time for many months. This period may be shortened artificially by the use of substances such as cane sugar.

The germination process resembles that of other species of *Urocystis*. A short, hemispherical promycelium develops, and from this arises a whorl of branches which grow indefinitely in the form of a mycelium without bearing sporidia. Septation appears early and the new branches generally arise below the septa. The older cells gradually lose their protoplasm, which becomes concentrated in the growing tips. The cells are easily broken apart, and detached segments, capable of further growth, are commonly found. *U. cepulae* lives and grows as a saprophytic mycelium in the soil for an indefinite period, probably for years, especially where there is an abundant supply of organic material. It enters the soil in the form of spores or mycelium from the buried parts of diseased onions, and can be widely disseminated by detached mycelial cells carried by wind, rain, implements, &c. The number of years which must elapse before onions can safely be grown on infested land must be decided by the duration of this saprophytic mycelial existence, since the author has never observed sporidia nor have spores ever been found in culture. Cultures exposed for two months to severe winter weather still grew luxuriantly when brought back to the laboratory.

The range of media upon which the fungus will grow is almost unlimited. A list is given of those used by the author, together

with details of the behaviour of the fungus on each, and the microscopic characters of the mycelium are briefly described. Sugar in the media was found greatly to increase development, and is probably responsible for the rapid growth of *U. cepulæ* in the onion. Starch furnishes a very poor source of carbon, and a small amount of acid checks growth. At an early stage the mycelium disintegrates into short, plump cells which probably take the place of sporidia as a means of dissemination.

Infection of the onion seedlings by the spores or mycelium in the soil occurs from the second day after germination till the appearance of the first leaf on the side of the cotyledon, namely, a period of about twelve days in the greenhouse. Infection occurs only through the cotyledon, any part of the epidermis of which may serve as the point of entry, and many infections may take place on the same cotyledon. The infecting hypha bores through the outer wall of the epidermal cell, inside which it forms a hyphal coil from which branches then pass through the inner wall into the intercellular spaces, where they continue during the whole of their subsequent development. Under favourable greenhouse conditions the incubation period to the first externally visible symptoms of infection is about five days. Large, complicated haustoria are sometimes formed in the host cells. Infected plants may recover if the fungus fails to reach the growing zone, but if the latter is once invaded most, if not all, of the leaves subsequently formed will contain lesions.

The approach of sporogenesis is first indicated by the massing of the mycelium in dense tangles between the cells of the mesophyll. Hyphal 'nests' are thus formed from which the spores develop in sori. The spore begins as a lateral or terminal branch which curves back on itself in the form of a crozier and may continue to grow into a spiral. Branches arise from this curved hypha to form a close covering around its terminal cell which becomes the fertile central cell of the spore ball. By adhesion of the cells of the covering hyphae and rapid expansion of the fertile cell, the enclosing hyphae are separated into the scattered elements which appear as the sterile covering cells of the mature spore. The fertile cell contains a single, large nucleus, probably the result of fusion as in allied species, though at what stage the latter occurs was not determined; and each sterile cell has a single, small nucleus. As the sorus develops the host tissues above it dry out and may split open to liberate the mature spores.

Interim Report of the Dominion Botanist for the year ending March 31, 1922.—*Dominion of Canada Dept. of Agric., Div. of Botany*, 73 pp., 3 figs., 1922.

This report contains an account of the work of the Dominion Division of Botany by H. T. Güssow, Dominion Botanist, and also of that of the Field Laboratories of Plant Pathology at Charlottetown, Prince Edward Island, by J. B. McCurry, at Fredericton, New Brunswick, by G. C. Cunningham, at St. Catherine's, Ontario, by W. H. Rankin, at Saskatoon and Indian Head, Saskatchewan, by W. P. Fraser, and at Summerland, British Columbia, by H. R. McLarty.

Among the items of interest the following may be mentioned. An account is given of the outbreak of white pine blister rust [*Cronartium ribicola*] in British Columbia [see this *Review*, i, p. 455], where fortunately the susceptible native pines, *Pinus monticola*, *P. flexilis*, and *P. albicaulis*, only form about 0·8 per cent. of the total stand of timber. Only the coastal region has as yet been found infected and legislative steps are being taken to prevent further dissemination of the disease.

During 1921 the work of seed potato inspection and certification was carried on as usual, the first inspection being made when the plants were in bloom, and the second just before they reached maturity. A considerable extension of territory was included in the year's activities, notably in Saskatchewan and Alberta. The total area of fields inspected throughout the country comprised nearly 8,000 acres, of which rather less than half passed the two inspections. Thirty inspectors were employed on the work for varying periods during the year. Full details of the standards employed in grading the crop are given.

An important feature of the report is the detailed account of leaf curl and mosaic of raspberries by Rankin and Hockey (pp. 30–60), which supplements their previously published studies on these diseases [see this *Review*, i, p. 218 and ii, p. 17.]

In a preliminary report on the strains of stem rust of wheat (*Puccinia graminis*) in Manitoba, Alberta, and Saskatchewan, W. P. Fraser states that Strain XVII was much more common and widely distributed during the period 1919–21 than any other. The occurrence of Strains III, IX, XI, XII, and XVIII, however, was also reported. As in previous years, the disease appeared first in the south and later in the north. No evidence of overwintering on grasses was obtained, the observations indicating that the spring attack appears first on the wheat and only spreads later to the grasses.

Experiments were carried out to test the efficacy of dusts for the control of cereal smuts under Western Canada conditions and to compare it with formalin treatment. Marquis wheat was shaken in a container with spores of the stinking smuts of wheat (*Tilletia tritici* and *T. levis*). Part of the infected grain was then dusted with anhydrous copper sulphate, with and without the addition of calcium carbonate or lime. It was found that both copper sulphate and lime (1–1), and copper sulphate and calcium carbonate (1–1) reduced the amount of smut to a trace (0·65 and 0·78 per cent. respectively), but were slightly inferior to formalin (1–320), which completely eliminated the disease. In a similar experiment with oats the seed was dusted with spores of *Ustilago avenae*. Copper sulphate and lime, and copper sulphate and calcium carbonate reduced the infection to 0·03 and 0·02 respectively, which again was not quite equal to the results obtained by the use of formalin. Copper carbonate, which has been found to be effective elsewhere, was not available at the time of testing.

Smut of western rye grass (*Agropyron tenerum*) was effectively controlled by the ordinary formalin treatment. The smut closely resembles that of brome grass (*Ustilago bromivora*) in morphological characters. To test their biological identity, commercial

seed of *A. tenerum* was heavily dusted with spores of *U. bromivora* from *Bromus ciliatus* but the resulting crop was no more heavily smutted than that from the balance of the commercial seed. This result indicates that these smuts may be biologically distinct.

Experiments in the control of bunt of wheat by the dry formalin method (1 part of 40 per cent. formalin to 1 part of water applied at the rate of 1 quart to 50 bushels of grain) have been reported frequently to result in reduction of germination. Experiments during the period under review on Marquis wheat showed no injury to the seed, but the treatment is not recommended on account of the possible dangers under certain conditions.

Leaf rust of wheat (*Puccinia triticina*) appeared early in Saskatchewan and Alberta in 1921, and was very severe in the former province. In south-eastern Saskatchewan the losses from this and stem rust are estimated at 20 per cent. of the crop.

There are numerous other records of general interest for which the report itself must be consulted.

LÜSTNER (G.). **Ergebnisse der Prüfung neuer Mittel gegen Peronospora, Oidium und Heu- und Sauerwurm in den Jahren 1920 und 1921.** [Results of the testing of new methods for the control of *Peronospora*, *Oidium*, and Vine moth in the years 1920 and 1921.]—*Ber. höh. staatl. Lehranst. Wein-, Obst-, und Gartenbau zu Geisenheim-am-Rhein, 1920–21*, pp. 79–85, 1922.

Excellent results were obtained by the use of kurtakol [see this *Review*, ii, p. 44], a copper compound in colloidal form manufactured by the firm of Dr. Kurt Albert at Biebrich. The copper content of the mixture is about equal to that of Bordeaux mixture, but kurtakol works out in practice at a cheaper rate owing to the smaller quantities required and the absence of lime. Experiments extending over a period of five years have shown that kurtakol is quite as effective as Bordeaux mixture against *Plasmopara viticola*. In 1920 only two applications were given, on 7th and 28th June respectively, the mixture on the first occasion consisting of 500 gm. kurtakol to 100 l. water, and on the second of 660 gm. to 100 l. The vines remained healthy throughout the summer and autumn. Comparative tests with Bordeaux mixture and nicotine gave somewhat inferior results. Kurtakol is very easily prepared for use; it does not clog the spraying apparatus or burn the foliage, and may altogether be most highly recommended.

Perocid (0·5 and 1 per cent.), also prepared by Dr. Albert's firm, was applied on 8th and 17th June and 5th August. *Plasmopara* was satisfactory controlled, but, as with Bordeaux mixture, the autumnal discoloration of the leaves set in earlier than after the use of kurtakol.

Nosperal 1781 and 1782 (Dyeworks, Höchst-am-Main) contain 8 per cent. copper against 24 per cent. in copper sulphate. They are somewhat cheaper than copper sulphate (although the initial outlay is approximately equal) on account of the smaller quantities required, namely, 1 per cent. at the second and third applications as compared with 1·5 and 2 per cent. of copper sulphate. The mixtures are prepared by dissolving the powders in water and neutralizing

them on the following day with pit lime. Three applications were given, on 7th and 24th June and 7th August, with excellent results. Nosperal 1781 was slightly superior to 1782, chiefly in its physiological effects, the foliage remaining exceptionally luxuriant in colour and development.

A lye derived in large quantities as a by-product at an aniline dyeworks had good adhesive properties but caused severe burning of the foliage.

A preparation named 'Kupferpasta-Bosna', supplied by the Bosnian Electricity Company in Vienna, gave very good results after two 1 per cent. applications on 11th and 24th June respectively.

Oidium tuckeri on Portuguese vines was adequately controlled by four applications, on 5th and 24th June and 7th and 30th July, of colloidal sulphur (3 and 6 per cent.) from Dr. Thiele's chemical works, Berlin. The untreated controls were very severely attacked. In 1920 it was successfully applied in conjunction with Bordeaux mixture for the simultaneous control of *Plasmopara* and *Oidium*.

The summer of 1921 was very unfavourable for the continuation of the experiments, *Plasmopara* being entirely absent on account of the drought. The control of *Oidium* with sulphur was complicated by the formation of sulphuric acid on the sprayed foliage and fruit, due to the brilliant sunshine. A new preparation from the Höchst Dyeworks, known as 'Elosal', produced very good results, but requires further testing.

Forty-seventh Annual Report of the Ontario Agricultural College and Experimental Farm 1921.—*Ontario Dept. Agric.*, 55 pp., 1922.

The section of this report devoted to botany (pp. 34–39) contains various references of phytopathological interest. Smuts and rusts of cereals were extremely prevalent and caused heavy losses. The damage caused by oat smut [*Ustilago avenae*] in some of the fields examined was estimated at 15 per cent. Leaf rust of oats [crown rust, *Puccinia lolii*] was so severe that many crops were entirely destroyed. In the eastern sections of the Province apple scab [*Venturia inaequalis*] was very severe, and the value of spraying was again demonstrated, 80 to 95 per cent. of the fruit in thoroughly sprayed orchards being free from the disease. Other prevalent diseases were plum pockets [*Exoascus pruni*], maize smut [*Ustilago maydis*], stem blight of asters, and strawberry leaf scorch [*Mollisia earliana*]; the latter was particularly severe in the Ontario Lake Shore District on the varieties Glen Mary, William Belt, and Ruby.

Investigations carried on to determine the best source from which to obtain seed potatoes free from leaf roll and mosaic showed that the lowest average percentage of leaf roll occurred in Green Mountain potatoes from Northern Ontario and Maritime Provinces stock (·5 and ·6 per cent. respectively) and the highest in Irish Cobblers from Old Ontario common stock (8·2 per cent.).

Spraying experiments in the control of late blight of celery [*Septoria apii*] have been conducted for the past nine years with a variety of fungicides, of which only liquid Bordeaux mixture

has given uniformly satisfactory results. Bordeaux dust was effective, but less so than the liquid mixture.

The results of four years' trials with dry formaldehyde for the control of oat smut [see this *Review*, i, p. 436 and above, p. 254] have proved uniformly satisfactory. In no case has there been more than a trace of smut in any of the fields sown with treated seed, whereas in the control plots the average incidence of infection was 4·32 per cent. The advantages of this method over those in general use are simplicity, rapidity, and facility of application.

Winter blight (also locally known as 'streak') is a common disease of greenhouse tomatoes in Ontario, and is in some cases severe enough to interfere with the production of a profitable winter crop. The disease also occurs in heavily manured fields. The results of experiments conducted every year since 1914 indicate that the disease is due to soil conditions and not to any parasitic organism. Satisfactory control has been obtained by the addition of phosphoric acid and potassium to the soil.

Division of Plant Pathology and Physiology.—*Thirty-fourth Ann. Rept. Texas Agric. Exper. Stat.*, 1921, pp. 17–19, 1921. [Recd. 1923.]

Blossom-end rot of watermelons was found to be due to a *Diplodia* which did not differ essentially from *D. tubericola*, causing the so-called 'Java black rot' of sweet potatoes. Numerous cross-inoculations of the *Diplodia* isolated from the watermelon on the sweet potato and vice versa indicated that the two strains were identical and may readily pass from one host to the other. The two crops should therefore not be allowed to succeed one another. Cross-inoculations with the anthracnose fungus of watermelons, *Colletotrichum lagenarium*, showed that the latter readily infects cucumbers, cantaloupes, squashes, gourds, and citrons. The fungus from any of these hosts is easily transmissible to the others.

Investigations of the Texas root rot fungus, *Ozonium omnivorum*, during 1921 tended to verify the assumption that the fungus hibernates on susceptible roots which remain alive in the soil. The value of crop rotation for reducing the incidence of the disease is definitely indicated, and absolutely clean culture is essential. The hosts of the fungus are being determined, and a full report on the disease is in preparation.

A *Fusarium* from rotted stored potatoes was repeatedly isolated, and found to cause 100 per cent. infection when inoculated into healthy potatoes. The fungus in some respects resembled *F. oxysporum*, the cause of wilt disease, but further investigations are necessary to determine its systematic position.

It has been ascertained that the causal organism of tomato wilt (*Fusarium lycopersici*) reaches every part of the plant, and it was even isolated from the fruit.

Cabbage in the Rio Grande Valley was severely attacked by *Fusarium conglutinans*, while downy mildew (*Peronospora effusa*) was the chief disease of spinach observed. An apparently new and undescribed disease, probably of bacterial origin, attacked lettuce,

causing a burning of the outer edges of the foliage and penetrating into the inner leaves of the head, where it led to the development of numerous small spots.

RUSSELL (H. L.) & MORRISON (F. B.). **New pages in farming. Annual Report of the Director, 1920–1921.**—*Wisconsin Agric. Exper. Stat. Bull.* 339, 142 pp., 40 figs., 1922.

In the section of the *Bulletin* devoted to plant pathology (pp. 32–48) the following references are of interest. The investigations of wheat scab and blight [*Gibberella saubinetii*] carried out by J. G. Dickson were chiefly concerned with the temperature and moisture relation of the disease. The results of greenhouse and outdoor experiments both indicated that the disease is most severe in wheat at relatively high soil temperatures (61° to 75° F.), whereas in maize it is worst at lower temperatures (46° to 68° F.). It was also shown that wheat flourishes best at low temperatures unfavourable to the development of scab (46° to 53° F.), while maize requires for its optimum growth higher temperatures than the fungus (68° to 82° F.). A study of the influence of soil moisture on the disease showed that in fairly dry soil, containing 30 per cent. of the moisture-holding capacity, over 40 per cent. of the inoculated wheat seedlings blighted at a temperature ordinarily unfavourable to scab (46° F.), as compared with a complete absence of blight at the same temperature where the soil moisture was 60 per cent. of the water-holding capacity. Disease-free seed at 30 per cent. moisture made very good growth.

Field observations during the past two seasons have shown that the scab fungus, after infecting the anthers of the wheat flowers, develops in the adjacent tissues in the glumes surrounding the growing kernel. The percentage of scab was found to depend on the number of anthers remaining enclosed in the glumes. The important commercial varieties of winter wheat, Turkey, Kharkov, Kanred, Fultz, and others showed high percentages of anthers remaining within the glumes, which was correlated with severe infection. Specific attempts were made, therefore, to select individual plants with open anthers from the varieties in which this character was normally absent. Three strains of Turkey wheat were obtained with the required anther formation and the resulting plants showed only 2 or 3 per cent. of scab as against 30 to 40 per cent. in the control plots.

Root rot of maize (*G. saubinetii*, *Diplodia zeae*, and *Fusarium moniliforme*) is a most important and dangerous disease throughout the maize-growing section of the United States, a conservative estimate of the total loss in 1919 being over 125,000,000 bushels, and since that date there has been no decline in the severity of the disease. Dry ear rot (*D. zeae*) is prevalent chiefly in the warmer localities, but the wheat scab organism, as shown above, is more destructive in the cooler sections of the maize-growing areas, such as Wisconsin.

Owing to the dry spring and summer of 1921 the incidence of apple scab [*Venturia inaequalis*] was so slight that the results of a series of comparative spraying experiments carried out by G. W. Keitt are of doubtful significance. Bordeaux mixture (4-4-50),

caused a serious russeting of the fruit, but a full schedule of [liquid] lime-sulphur (1–40) and dry lime-sulphur (4–50), gave more satisfactory results. Generally speaking, the dusts, of which sulphur-lead arsenate (90–10), copper-lime-lead arsenate (10–80–10) and sulphur-dry lime-sulphur-lead arsenate (75–15–10) were tested, were slightly inferior to the sprays.

Cherry disease investigations were continued, especially with a view to the control of leaf spot [*Coccomyces hiemalis*], which was very severe in 1921 owing to the heavy rains during the latter part of August. Three applications of Bordeaux mixture (3–3–50), gave the best results, the treatment being carried out (1) just after the petals fell, (2) about a fortnight later, and (3) soon after harvest. In general, dust treatments (with the same dusts as for apple scab) did not give very satisfactory control. The results of the investigations showed the necessity of increased attention to the control of leaf spot after harvest.

Anthracnose of black raspberries [*Gloeosporium venetum*] is particularly severe on the Cumberland variety, and has greatly reduced the Wisconsin crop. The results of experiments carried on at Madison by L. K. Jones showed that the disease could be adequately controlled by the application of the following sprays; (1) delayed dormant spray, lime-sulphur (1–10), or Bordeaux mixture (6–6–50), plus an adhesive, such as glue, gelatine, or casein-lime, after the unfolding of the first few leaves, (2) a summer spray, lime-sulphur (1–40), or Bordeaux mixture (3–3–50), with an adhesive, about one week before blossoming.

Trials were carried out by W. B. Tisdale with three early varieties of yellows-resistant cabbage, namely, Copenhagen Market, Ball Head Early, and Glory of Enkhuizen. The first selections were made in 1919 from 'cabbage sick' fields, and in 1920 seed was produced from a few self-pollinated plants. Plants from this seed set in 'sick' soil in 1921 showed a high degree of resistance to yellows, together with other desirable qualities. Further experiments with these strains are in progress.

J. Monteith's studies on the relation between club root of cabbage (*Plasmodiophora brassicae*) and soil temperature and humidity showed that the disease developed through a wide range of temperature (48° to 86° F.), the most active growth taking place at about 68° F. Club root did not develop in most of the soils used when they were maintained with a moisture content below one-half of their water-holding capacity. At a higher moisture content the disease appeared in a severer form. Poorly drained land, therefore, should not be used for cabbage culture, when club root is prevalent.

McRae (W.). **Report of the Imperial Mycologist.**—*Agric. Res. Inst. Pusa, Scientific Reports 1921–22*, pp. 44–50, 1922.

Piricularia oryzae, the cause of the destructive 'blast' of rice in other countries, has been recorded from many parts of India, but the damage to the crop is not usually considerable. In Madras and Bihar fifty per cent. of the seedlings in the seed-bed may be infected slightly, but after being transplanted the plants may ulti-

mately become almost free from disease. Infection experiments, and the available meteorological records, indicate that a high moisture content of the air and a definite temperature are the most important factors that influence the spread and severity of the disease. Species of *Piricularia* similar to that on rice have been found on *Eleusine coracana* (on which it sometimes occurs in epidemic form with a resulting loss of grain that may amount to 50 per cent.), *Panicum repens* (a wild grass common in the rice 'bunds' and water channels), *Setaria italica*, *Paspalum sanguinale*, *Triticum vulgare*, and *Panicum ramosum*. Cross-inoculation experiments and field observations indicate that, although the morphological and cultural characters of the different forms are not very distinct, their behaviour on different hosts under Pusa conditions shows definite biological peculiarities; thus the forms on *Oryza*, *Panicum repens*, and *Paspalum* are each restricted to its own host, while those on *Eleusine*, *Setaria*, and *Triticum*, although interchangeable among themselves, will not infect the first three hosts. The strain on *Panicum ramosum* has been but recently found and its behaviour has not yet been tested.

Two other diseases of rice were investigated. One of them is due to a sclerotial fungus which has not yet been identified and which causes light yellow-brown spots on the leaf sheath, sharply demarcated by a dark reddish-brown line. Under favourable conditions the fungus spreads over the whole plant, which is rapidly killed. Its morphological characters, as well as the symptoms of the disease caused by it, closely resemble those of the 'Djamoer Oepas' disease of sugar-cane in Java and India; work is in progress to determine whether the fungi are identical in both cases. The second disease, resulting in a failure of the plant to produce grain, and recorded from Burma, Assam, and the Central Provinces, is possibly caused by a species of *Cephalosporium*, although there are indications that soil conditions may be the predominant factor in determining the incidence of this fungus as a parasite.

Preliminary experiments have shown that the smut, *Tolyposporium penicillariae*, of 'bajra' (*Pennisetum typhoideum*) is amenable to seed treatment with hot water (10 minutes at 60° C.) or hot formalin vapour (20 seconds at 98° C.), though these treatments slightly reduce the percentage of germination. The presence of the mycelium has been traced in apparently normal grain, occupying the scutellum and the seed coat near the embryo, thus confirming field observations which suggest that the disease is carried in the seed. Experiments to ascertain whether infection takes place through the flowers indicated that this is not the case. Considerable annual losses are caused by the smut of this important cereal in India and control measures on a larger scale are being tested.

Other cereal diseases under investigation include those caused by *Fusarium*, *Diplodia*, and *Acrothecium* on 'bajra' and maize, and by *Helminthosporium* on rice, barley, wheat, sugar-cane, and millets. The *Helminthosporium* work, in general, confirmed the results previously reported [see this *Review*, i, p. 160].

The interesting smut *Urocystis coralloides* again appeared in the same field on the roots of Indian mustard [*Brassica*]. The infected

plants are stunted and branch feebly. Attempts to germinate the spores failed.

The study of *Macrophoma corchori* was continued both at Pusa and at Dacca. This fungus causes a stem rot of jute, which is most severe in soils deficient in potash. Applications of sodium sulphate appear to have a considerable influence in reducing the incidence of this parasite. The pycnidial stage appears only on the host plant; in artificial culture the fungus remains sterile and produces small, black sclerotia, in which form it appears to be identical with the organism previously described in India as *Rhizoctonia solani* Kühn [*Mem. Dept. Agric. India*, Bot. Ser., iv, 6, 1912].

McDONALD (J.). **Annual Report of the Mycological Division.**—*Ann. Rept. Dept. of Agric. Kenya for the year ending 31st March, 1921*, pp. 81–82, 1922.

A few diseases of minor importance were observed for the first time. Amongst these may be mentioned 'red mould' of wheat, due to the fungus *Fusarium culmorum*, which was reported from the Kericho district, where its occurrence was associated with excessive humidity.

Ustulina zonata, which frequently attacks the roots of tea, coffee, rubber, &c., on old forest land, caused numerous deaths among pear and peach trees planted under similar conditions. Cases of flax wilt (*Fusarium lini*) were reported from all the principal flax-growing centres.

Report on the Department of Agriculture, Barbados, for the financial year, 1921–22, 19 pp., 1922.

The Director of Agriculture, Mr. J. R. Bovell, reports the occurrence of mosaic disease of sugar-cane, which was first observed in a small plot in October 1920. In spite of attempts to eradicate the disease, it spread with great rapidity and at present exists practically all over the island.

The Assistant Director, Mr. B. A. Bourne, furnishes a report on the entomological and mycological work of the Department. Amongst the fungous diseases studied most attention was given to root disease of sugar-cane, and the results of this investigation led to the following conclusions. Root disease occurs both on typical black and red soils, ratoon canes being particularly susceptible. In typical cases either *Rhizoctonia solani* or *R. pallida* was found associated with freshly diseased and dying roots, and in advanced stages of the disease the tissues of the basal portions of the stem were infected by one or other of these fungi. A species of *Fusarium* may also be present. *Marasmius sacchari* has only been isolated from dead roots. Inoculation experiments proved conclusively that both *R. solani* and *R. pallida* are parasitic and capable of causing root decay and reproducing the typical symptoms of the disease, including stunting of the plant and yellowing of the leaves. Similar tests with *M. sacchari* and the *Fusarium* gave negative results. In the field the disease appears to be favoured by a high soil temperature combined with absence of humidity. The following control measures are recommended: planting of resistant

varieties and of healthy cuttings from disease-free plants; suitable rotation of crops; proper tillage and drainage; and thorough trashing of fields of young plants and ratoon canes in order to conserve the soil moisture and keep down the temperature.

The usual fungi, *Colletotrichum falcatum* and *Cephalosporium sacchari*, associated with red rot of sugar-cane; *Leptosphaeria sacchari* causing ring spot of the leaves; *Thielaviopsis paradoxa* producing pineapple disease, and *Cercospora vaginae* responsible for a red spot of the leaf sheath, were observed on several occasions. The fungus associated with eye spot of sugar-cane leaves, which is new to Barbados, was isolated in pure culture and found to agree with the description of *Helminthosporium sacchari*, except in the much greater length, often up to 75 μ, of the spores. The writer believes that *Colletotrichum falcatum*, which was frequently found to be associated with the diseased spots, was largely responsible for the rapid death of the leaves subsequent to attack by *H. sacchari*. Another fungus not previously recorded from Barbados was commonly found to be associated with dead and dying cane leaves and leaf sheaths, namely *Rhizoctonia grisea* (*Sclerotium griseum*). The writer isolated this fungus from single sclerotia from a dying cane leaf sheath of the variety Ba. 6032.

Imphee (*Andropogon sorghum saccharatus*) suffered from a root disease believed to be due to the attacks of *Rhizoctonia ferrugena*. Pure cultures developed numerous reddish-brown sclerotia about 4 mm. in diameter.

A tree of lignum vitae (*Guaiacum officinale*) was found suffering from what appeared to be a fungous disease. All along the stems and twigs, both green and mature, minute pycnidia could be seen embedded in the epidermal tissues. Two fungi were isolated from the diseased tissues, one of which was a species of *Phoma*, and the other *Phomopsis stewarti*, which is stated to be parasitic on *Cosmos* in the United States. The pure cultures of the latter agreed with Stevens's description, and produced on sweet potato agar both *Phlyctaena*- and *Phoma*-like spores.

Report on the Agricultural Department, St. Lucia, 1921.—*Imper. Dept. Agric. W. Indies*, 31 pp., 1922.

This publication contains (pp. 8-9) a copy of a report by S. F. Ashby, on a banana disease which has been known in the island since 1912, and which chiefly affects the Gros Michel variety. As a result of successful attempts to isolate the causal organism, it is now stated that the disease is identical with the well-known Panama disease due to *Fusarium cubense*. It appears to be confined to the north-western districts. Attention is called to the danger of transmitting this disease to Barbados, where it is as yet unknown, with the banana trash that might accompany shipments of Gros Michel fruit.

Welles (C. G.) & Roldan (E. F.). **Solanaceous wilt in the Philippine Islands.**—*Philipp. Agric.*, x, 8, pp. 392-398, 3 pl., 1922.

Bacillus solanacearum causes the most serious disease of tomato, eggplant, tobacco, and other solanaceous plants in the Philippine Islands. Young tobacco seedlings attacked by this organism show

a slight wilting of one or more leaves, followed within twenty-four hours by the collapse of the entire plant, which subsequently dries up. The stunting and more or less permanent wilting, without killing, of larger plants is common. The annual loss varies from 5 to 15 per cent. of the crop.

Eggplant seedlings are more resistant than tobacco or tomato. The diseased plants first show wilting of the old, outer leaves, followed within a few days by the death of the entire plant. In older plants the course of the disease is very gradual and is never accompanied by total collapse owing to the support of the woody stems. The fruits frequently become wilted and swarm with bacteria.

Tomato seedlings, especially after transplanting, are very susceptible to this disease, total loss of the crop being common. The older leaves wilt first, followed within twenty-four hours (or a few days in wet weather) by the collapse of the plant. In large plants one or two branches are first attacked, the infection rapidly spreading over the entire growth. The fruits are also frequently attacked.

Castor bean (*Ricinus communis*) exhibits similar symptoms to those described above. No plants over 1 metre in height were observed to be affected.

In *Chrysanthemum coronarium* (apparently a new host) the attack does not result in the collapse of the plant but kills the green parts, leaving a tall, leafless stem. In this case the organism has not yet been studied in sufficient detail to warrant a definite statement concerning its identity, but it is believed to be *B. solanacearum*, though it produces a somewhat lighter pigment in culture than that from wilted solanaceous plants.

Attempts to control the disease by applications to the soil of copper sulphate, calcium oxide, calcium phosphate, and potassium chloride gave negative results. The only absolute method of control in infected soil appears to be a five years rotation of crops in which all hosts of *B. solanacearum* are excluded. The eggplant, however, may safely be planted during the rainy season, very few losses being sustained under Philippine conditions if it reaches maturity by the beginning of December.

MUNERATI (O.). **Osservazioni sulla recettività del Frumento per la carie.** [Notes on the susceptibility of Wheat to bunt.]—*Rend. Acc. Lincei*, xxxi, ser. 5 a, 1 sem., 3, pp. 125-129, 1922.

The author was induced to publish the present note, giving the result of his researches in the period 1912-1917, by Heald's paper on the relation of the spore load to the per cent. of stinking smut appearing in the crop [see this *Review*, i, p. 169].

Several series of experiments (a summary of which is given) to test the influence on infection by *Tilletia*, of the soil temperature at the time of germination of the wheat, and of the distribution of the spores on the integuments of the grain, led the author to the following conclusions, in agreement with those previously advanced by him.

The presence of even a very considerable load of *Tilletia* spores on the grain is not in every case sufficient to determine the infec-

tion of the seedlings, the latter being much more a function of the course and duration of the germination process of the grain. A rapid germination gives the plant a better chance to escape infection than a slow one. Seed disinfection, always advisable, is therefore of particular importance when sowing has to be done late in the autumn or early in the spring.

The theoretical probability of infection depends more on the distribution of the spores on the integument of the grain than on their total number. The further the spores are localized from the embryonal zone, the less the risk of the plants becoming infected. If, in practice, the possibility of infection does depend to a certain degree on the total spore load, this is due merely to the fact that the larger the number of spores, the greater the probability that some may find their way to the embryonal zone at germination. If the spores remained strictly localized to the apical zones of the grain, the seedlings would escape all possibility of auto-infection. In this connexion the little brush of hairs found at the pointed end of the grain, far removed from the embryo, is of considerable importance. Under natural conditions of infection the greater number of the spores lodge in these hairs, but they may become distributed over the rest of the grain by rubbing or other mechanical means. In the author's experiments it was found that grain to which spores were fixed by gum or paste was very heavily infected at low temperatures when the spores were attached to the embryonal zone, and lightly infected when the spores were fixed near the apical end. At higher temperatures the attack in both cases was slight, but the same differences in degree were observed.

It is clear from the above considerations that, when testing varieties or races of wheat for resistance to the fungus, or the efficacy of a method of seed treatment, the trials should be made under controlled conditions. In field experiments, the material should be sown at different dates during the presumably critical period, in order to ensure that in one series at least the host is in a condition of maximum susceptibility to the parasite. It is also important to ensure that an adequate amount of the infective material reaches the embryonal zone of the grain.

SMALL (W.). **Diseases of cereals in Uganda.**—*Dept. Agric. Uganda Circ.* 8, 19 pp., 13 figs., 1922.

In his introduction the author draws attention to the fact that the present list of cereal diseases in Uganda is necessarily incomplete, owing to the very limited time available for their investigation. Several of the parasitic fungi mentioned, such as maize rust and the red leaf spot of sorghum (*Colletotrichum graminicolum*), are constantly present in varying degrees, but cause little serious damage. Others again, such as the two wheat rusts (*Puccinia glumarum* has not yet been observed) and blast of rice (*Piricularia oryzae*) consistently reduce the yield of the crop. Direct remedial measures are impracticable in Uganda, and it is, therefore, all the more necessary to attend strictly to general sanitary measures—the burning of refuse, good cultivation, and the like. Scientific plant breeding to ensure the cultivation of disease-resistant varieties is also very desirable. The instruction of the natives in even the

most elementary principles of plant pathology is stated to have proved extremely difficult, but the present account is written in such a form as to help in the spread of information regarding the chief cereal diseases which are described. These are as follows:—

SORGHUM. Downy mildew (*Sclerospora* sp.), rust (*Puccinia purpurea*), red leaf spot (*Colletotrichum graminicolum*), leaf blight (*Helminthosporium turcicum*), grain smut (*Sphacelotheca sorghi*), and head smut (*Ustilago reiliana*).

MAIZE. Downy mildew (*Sclerospora* sp.), rust (*Puccinia sorghi*) [*P. maydis*], and leaf blight (*Helminthosporium turcicum*).

WHEAT. Black rust (*Puccinia graminis*), orange rust (*P. triticina*), loose smut (*Ustilago tritici*), leaf spot (*Leptosphaeria tritici*), mould (*Cladosporium herbarum*), and *Helminthosporium* leaf spot (? *H. sorokinianum*).

BULRUSH MILLET (*Pennisetum typhoideum*). Rust (*P. penniseti*), and *Sphacelia* disease. The latter is known from Tanganyika Territory on *Pennisetum spicatum*, and is common in Uganda on *P. purpureum* as well as on the bulrush millet, but all attempts to find its perfect stage have failed.

CROWSFOOT MILLET (*Eleusine coracana*). Leaf spot (*Phyllachora eleusines*).

RICE. Blast (*Piricularia oryzae*).

HEALD (F. D.) & SMITH (L. J.). **The dusting of Wheat for bunt or stinking smut.**—*Wash. Agric. Exper. Stat. Bull.* 171, 28 pp., 5 figs., 1922.

Copper carbonate, first used as a seed disinfectant by Darnell-Smith in New South Wales in 1915, has been submitted by the authors to a series of critical experiments designed to ascertain its efficacy.

Preliminary experiments were carried out in the spring of 1921 on the wheats Blue Stem and Jenkins Club, the grain being thoroughly dusted with 1 gm. of bunt [*Tilletia*] spores to 100 gm. of seed. The infected seed was divided into small lots, each of which received a specified treatment, before sowing. The results showed a relatively low percentage of bunted heads in the controls (13·6 and 3·2 respectively) owing to the weather conditions at planting, but they also showed a perfect control by copper carbonate dust (2 and 4 oz. per bushel) and by equal parts of finely powdered anhydrous copper sulphate and powdered calcium carbonate used at the rate of 2 oz. of the mixture per bushel. Copper sulphate gave 0 and 0·4 per cent. bunted heads, and formalin 0 and 0·7 respectively. Sulphur (10 lb. and 20 lb. per bushel) gave similar results, but is costly, and its efficacy is still open to question. Copper sulphate reduced the percentage of germination from 84·25 and 89·5 for the untreated to 67 and 65·5; formalin to 38·5 and 53·5; whilst copper carbonate dust (4 oz. per bushel) raised it to 98·5 and 96·5 respectively.

In similar experiments started in the spring of 1922 varying proportions of copper carbonate were used in order to ascertain the minimum quantity necessary to give effective protection. Three varieties were used, Marquis (resistant), Blue Stem (susceptible), and Jenkins Club (very susceptible), and the seed was dusted with bunt

spores in three degrees, 0·1, 0·4, and 1·0 gm. per 100 gm. of seed. The most heavily contaminated seed gave an average of 0·97 per cent. bunted heads for the treated seed against 40·57 per cent. for the controls. The following amounts of copper carbonate, ½ oz., 1 oz., 2 oz., and 3 oz. were added per bushel and the average results of the three varieties were 0·55, 0·09, 0·30, and 0·0 per cent. of bunted heads respectively. A mixture of equal parts of copper carbonate and hydrated lime used at the rate of 1 oz. and 2 oz. per bushel yielded 0·81 and 0·76 per cent. bunted heads respectively.

Experiments were also made with anhydrous copper sulphate mixed with equal quantities of calcium carbonate or hydrated lime. The former mixture (1 oz., 2 oz., and 4 oz. per bushel) gave an average of 1·15 per cent. bunted heads, and the latter (in similar quantities) 1·65, the controls yielding 23·26 per cent. The average for all copper carbonate tests was 0·41 per cent. bunted heads as contrasted with 1·4 per cent. for all tests with anhydrous copper sulphate. It seems therefore that anhydrous copper sulphate is not equal to copper carbonate, and that hydrated lime is not so satisfactory for mixing with the former as calcium carbonate.

A proprietary copper carbonate compound 'Corona' was tested and appeared to have a better protective action than pure copper carbonate carrying an equal amount of copper. 'Seed-o-San', an organic mercury compound, was not as efficient as the copper dusts.

In 1922 tests were carried out to show the comparative value of various seed and soil treatments in preventing bunt originating from wind-blown spores. Treatment was carried out with sulphur (200 lb. per acre and 20 lb. per bushel), copper sulphate (sprinkle of 1 lb. to 1 gall.), copper carbonate (2 oz. per bushel), anhydrous copper sulphate with calcium carbonate (1 oz. of each per bushel), copper sulphate (1 in 5) with or without a lime bath, and formaldehyde (1 in 40). All the treatments except sulphur (200 lb. per acre) and formaldehyde were effective to some extent, but the differences were not sufficiently pronounced to justify any conclusion as to the superiority of any particular treatment. A second similar series, but with the soil artificially infected, indicated that all the copper treatments brought about a reduction in the amount of bunt.

Tests were also carried out with copper sulphate, formaldehyde, and copper carbonate on different farms, and the latter gave the lowest average percentage of bunted heads.

The question as to whether wheat may be dusted with copper carbonate some months previous to seeding time without suffering injury was tested by treating four varieties with 2 oz. copper carbonate per bushel, ascertaining the percentage germination at intervals, and comparing the results with those of untreated seed. Treated seed was not injured by being kept eight months, but on the contrary showed a higher germination than the untreated samples. The stimulating effect of the copper carbonate treatment is often seen in the greater vigour of growth in the fields, even in the early spring.

On the basis of completed trials, the authors recommend the use of at least 2 oz. of finely powdered copper carbonate per bushel,

but also state that 3 oz. per bushel is worthy of trial for autumn seeded grain. The powder should test at least 50 per cent. metallic copper, and should be fine enough to pass through a 200 mesh sieve: the heavy copper carbonate for the metallic trades should be avoided. Too heavy seeding after using copper carbonate should be guarded against, as dry grain feeds faster than moist.

The wearing of some form of respirator during the treatment is recommended, and if this is unavailable then treatment must only be made out of doors, the apparatus being so arranged that the wind will carry the dust away from the operator. The application of the dust may be made in various ways, but a special dusting machine, consisting essentially of a rotating drum, is described, which keeps the dust enclosed while securing an even distribution on the grain. A blue print showing the dimensions of the machine can be had from the Station, Pullman, Washington, for 25 cents. Ordinary mixing by shovelling over the dusted grain is not recommended, as the dust is less evenly distributed and more easily inhaled than when shaken in a closed container.

ATWOOD (W. M.). **Physiological studies of effects of formaldehyde on Wheat.**—*Bot. Gaz.*, lxxiv, 3, pp. 233–263, 12 figs., 1922.

The tests described in this paper were undertaken in order to determine the exact nature of the effect of formaldehyde treatment on the physiological processes of seeds, as shown by wheat. Ordinary commercial formalin [termed formaldehyde throughout by the author, as by many recent American workers] was used, containing 39·3 parts per hundred by volume of formaldehyde gas.

In the first series of experiments the period of steeping in formalin at the strength usually recommended (1 : 320) was varied from 5 to 300 minutes. One-third of the seeds treated were grown in blotters in the customary manner, one-third in soil in porous clay germinators indoors, and one-third outdoors in pots of soil exposed to the weather and to a temperature of between 40° and 60° F. The graphs show that a dip of from 20 to 40 minutes only slightly reduces germination, but beyond 40 minutes the descending curves of germination are somewhat steeper, although the drop in most cases is not great. The seeds germinated in soil showed a somewhat greater percentage of injury than those grown in blotters. This phenomenon has also been observed by other workers, and an explanation of it has been suggested by Wallden on the ground that injuries to the coleoptile, while impeding progress in the soil, need not interfere with germination of the seeds in blotters.

In another series of tests the concentrations of formalin were varied from 1 : 40 to 1 : 320, and the treatment was applied for ten minutes at 20° C. As compared with the controls there was little injury apparent at the usual concentration of 1 : 320, but with a concentration of 1 : 160, the germination curves began to fall, and at 1 : 40 the germination was reduced by 40 to 60 per cent., both in the blotters and in the soil. As in the previous series the injury was greatest in the outdoor soil, less in the indoor soil, and least in the blotter tests.

Formaldehyde readily forms various polymers, but means for their identification are not satisfactory. The flocculent, white precipitate which forms when the commercial solutions are concentrated is ordinarily referred to as paraformaldehyde. If wheat is dusted with this precipitate, serious injury results, and tests with Turkey Red showed that germination was thereby reduced to only 9·5 to 15 per cent. The polymers persist on grain for many months, even if exposed to the air.

In the tests designed to determine the permeability of the seed coats to formalin, the grains were sealed one at a time to the end of a glass tube, into which formaldehyde solution was poured. After contact lasting three to four days, the dry tip of the grain, exterior to the tube, was sectioned and treated directly with the Schryver formaldehyde reagent. With long periods of exposure to high concentrations of formalin (1 : 8) penetration appears to be possible at either tip of the grain or on either face. Another method employed by the author was to measure the degree of semi-permeability of the seed coat indirectly by noting the weight increase of the seeds when soaked in distilled water and in formalin respectively, the latter in a high concentration (1 : 8) in order to render more conspicuous the difference. The results of these experiments lead to the conclusion that formaldehyde slowly penetrates the seed coat, and that when the grain is subsequently transferred to water, the formaldehyde gradually diffuses outward again.

Tests to determine the effect of formaldehyde on starch digestion in the grain are described and illustrated by graphs. They showed that diastatic activity is not entirely inhibited, but is retarded, and a reduction in the amount of starch digestion was noted corresponding with a rise in the concentration of the formaldehyde originally used in the treatment of the seed. It would, therefore, appear to be certain that formalin treatment lessens the availability of carbohydrates to the germinating seedling.

Attempts to determine the effects of formalin treatment on the amino acids of the grain failed, owing to difficulties of technique.

The elaborate respiration tests which were carried out demonstrated that formalin has a marked influence on the respiratory rate in concentrations of 1 : 80, the effect decreasing down to 1 : 320, the usual concentration in seed treatment. At concentrations from 1 : 400 to 1 : 1000 the effect on metabolism was negligible.

The effect of formalin treatment on the catalase activity of wheat is to depress the latter; as the concentration of the solution is increased, catalase activity as measured by oxygen yield from peroxides falls. The effect wears off to a certain extent with time, and it is suggested that the injury is due more to exterior members retaining the formaldehyde which had been in part volatilized, than to a permanent injury to the embryo having resulted from the treatment.

Speaking generally, the author thinks that the conclusions of Miss Hurd [see this *Review*, i, p. 25] that a polymer of formaldehyde is deposited on dried, treated wheat, and subsequent injury to the grain is incidental to the liberation of formaldehyde gas from the precipitate, are in harmony with his results. But he emphasizes the facts brought out in his experiments as indicating the

possibility of a reduction in the vitality of the seedling, even when germination is not diminished, by formalin treatment.

BRUNER (S. C.). **'La muerte de los Cocoteros.'** ['The death of Coco-nut trees.']—*Rev. Agric. Com. y Trab.* [*Cuba*], v, 1, pp. 9–10, 1922.

This is a critical review of a work by Celestino Bencomo with the above title, published in Havana in 1921, in which coco-nut bud rot is attributed to the activities of *Oryctes rhinoceros*. The reviewer completely disagrees with this view, as according to present knowledge no species of *Oryctes* exists in Cuba, and even if one accepts Bencomo's statement that *O. rhinoceros* is synonymous with *Strategus anachoreta* (this, and a very similar species, *St. titanus*, are not of very frequent occurrence in Cuba), the fact remains that the writer, in examining the first phases of the disease *in situ* has found no trace of these, or any other insects.

Although the writer is not convinced that a bacterium may not cause bud rot, he states that he has never accepted as conclusive the evidence pointing to *Bacillus coli* as the causative agent. The red ring disease, which in its effects resembles bud rot, but which is due to a nematode, *Aphelenchus cocophila*, probably exists in Cuba. *Phytophthora faberi* Maub., which Reinking considers the cause of bud rot in the Philippines, has been also proved by the writer to be pathogenic to young coco-nut palms in Cuba. Ashby in Jamaica found a similar fungus attacking coco-nuts and referred it to *Phytophthora palmivora* Butl., a species which causes a very serious disease of palms in India. According to Ashby, a similar disease exists in the western part of Jamaica. These diseases, which correspond closely in their characters to the disease as known in Cuba, have all been described since bud rot was attributed to *B. coli*, and further experimental work, which the writer has in hand, will be necessary before the true cause of death of the palms in Cuba can be established.

BALLARD (W. S.), MAGNESS (J. R.), & HAWKINS (L. A.). **Internal browning of the Yellow Newtown Apple.**—*U.S. Dept. Agric. Bull.* 1104, 24 pp., 2 col. pl., 1922.

Certain varieties of apples, including Yellow Newtown, Red and White Pearmain, Yellow Bellflower, and Missouri, grown in the Pajaro Valley of California, where two-thirds of the apple crop of the State are produced, are apt to develop in cold storage a brown discoloration of the flesh, known as 'internal browning'. The discoloration may appear at any point in the flesh of the apple, from the core outwards. In very mild cases a cross section reveals only a faint brown spot in the angle between two adjacent seed cavities. In more advanced cases the brown areas round the core may be accompanied by discoloured patches, of varying dimensions and intensity, in the outer flesh of the fruit. There are no external symptoms of the disease, and it does not develop in the fruit while on the tree or if the apples are kept at room temperatures after picking.

Prolonged investigations have shown that internal browning is a physiological disease due to nutritional disturbances which affect

the fruit. Light crops of large, coarse-textured apples of the type commonly produced by the cool temperature, high humidity coupled with frequent fogs, and fertile soil of the Pajaro Valley, are particularly liable to the trouble. In the foothills and interior valleys, where the temperature is higher, there is more sunshine, fewer fogs, and lower humidity, the fruit produced is so little liable to the disease that it has no commercial importance. In seasons of very high crop production the trouble appears to be practically non-existent. During the years when browning was prevalent, the fruit from trees bearing heavy crops was much less affected than that from trees with a low yield. A light crop associated with good leaf production is usually affected with extensive browning in storage. Experiments showed that heavy thinning of the fruit, combined with girdling of the branches, produced fruit with a high sugar and acid content and a tendency to brown severely, while partial defoliation of well-loaded branches, which lowered the sugar and acid content of the fruit, gave sound apples. On the whole, all the evidence obtained supports the conclusion that browning is associated with the carbohydrate nutrition of the tree, being most marked in trees which normally produce fruit of rather low sugar content whenever circumstances tend to increase that content. Heavy applications of stable manure increased the percentage of browning, as was also the case with nitrogenous fertilizers, except where the crop was very heavy.

Internal browning has been proved to develop most extensively in cold storage at a temperature of 32°F. On withdrawal from storage there is usually a marked increase in the percentage of browning, which is therefore much more severe by the time the fruit reaches the consumer. By maintaining the temperature of the cold storage chambers at 36° to 38°F. the danger of internal browning may be largely eliminated, and since 1917–1918, when most of the apple storage houses in California were raised to a temperature of 36°, little loss has been incurred from the disease.

OSTERWALDER (A.). **Weitere Versuche zur Bekämpfung des Apfelmehltaues.** [Further experiments in the control of Apple mildew.] *Landw. Jahrb. der Schweiz*, xxxvi, 6, pp. 833–834, 1922.

The author claims that apple mildew (*Podosphaera leucotricha*), which has proved refractory to spraying in repeated experiments with various fungicides at Wädenswil, can be sufficiently held in check by persistent pruning.

From a susceptible Boiken apple, 122 infected shoots were removed in 1916, and 31 in 1917, since when the attack has been negligible.

MÜLLER-THURGAU (H.). **Eine durch ein Gloeosporium verursachte Krankheit bei Cyclamenpflanzen (Cyclamen persicum).** [A disease of Cyclamen (*Cyclamen persicum*) plants caused by a *Gloeosporium*.]—*Landw. Jahrb. der Schweiz*, xxxvi, 6, pp. 824–826, 1922.

Nearly 30,000 cyclamen plants belonging to a large commercial nursery-garden at Zurich were attacked by a disease which

resulted in the death of the young leaves and blossoms. A species of *Gloeosporium* was isolated from the affected parts. The spore masses were reddish in colour and the unicellular spores about 15 μ in length by 2·6 to 5·4 μ in thickness. The morphological characters of the fungus resemble those of *Glomerella rufomaculans* var. *cyclaminis*, which attacks cyclamens in the United States. The symptoms of the Swiss and American diseases, however, are widely divergent, and the causal organisms are believed by the author to be quite distinct.

ANDERSON (H. W.). **Orchard practice for the control of blister canker of Apple trees.**—*Illinois Agric. Exper. Stat. Circ.* 258, 16 pp., 12 figs., 1922.

Notwithstanding the efforts of Illinois fruit growers to exterminate blister canker [*Nummularia discreta*], the losses from the disease have increased annually. Blister cankers occur on the large limbs and trunks of trees, especially near large wounds; when old they are easily recognized by the presence of 'nail heads', the characteristic fruiting bodies of the fungus. When the bark is worn away, the nail heads, which constitute the ascigerous stage of the fungus, stand out about one-quarter of an inch from the wood. On younger cankers the fruiting bodies accumulate under the bark and cause small, blister-like protuberances, which later split open in the form of stars. The ruptured segments curl backwards, exposing the conidia of the fungus in a dust-coloured mass. The inner bark of affected trees may, early in the disease, present a characteristic mottled appearance, due to the development of annular black lines in the tissues.

The spores of the fungus may be washed down the bark and infect the lower parts of the tree, or may be carried to other trees, sometimes miles distant, by birds or insects. The implements of workmen are frequent agents of distribution. Dissemination by air currents appears to be slight. Spores alighting on healthy tissues or small wounds rarely cause infection, ideal conditions for which are furnished by large, exposed wounds, such as those caused by the sawing or breaking off of large branches. The fungus grows down into the heartwood, usually causing definite brown streaks, and gradually becomes distributed throughout the woody portion of the tree, even into the roots. Within a year the typical external symptoms of the disease are visible. The conidia play a relatively unimportant part in the distribution of the disease, their capacity for infection being very limited. The mature nail heads containing the active ascospores may take two or more years to reach maturity. Young trees, under six years of age, are rarely attacked, and no special precautions are necessary in the pruning of the trees up to ten years old, except when they are in the vicinity of older, cankered orchards or when the pruning tools have been used on cankered trees.

Blister canker occurs on nearly all the commercial varieties of apple in Illinois. Ben Davis being particularly susceptible. The cultivation of this variety in Illinois should therefore be discontinued, especially as the orchards are already overstocked with it. Its elimination would imply an almost total eradication of the

disease, which on moderately susceptible varieties, such as Yellow Transparent and Chenango, can be controlled by appropriate sanitary measures.

One of the most important preventive measures is the immediate dressing of wounds on the older trees with a coat of shellac and then with a layer of gas tar. The same treatment may be applied to areas of the bark injured by sun-scald, &c. All tools used in the excision of cankers, pruning, or other operations, should be sterilized with mercuric chloride (1 in 1,000) or copper sulphate. The removal of cankers, which should be carried out in the winter, defers the spread of the disease for several years if a good callus is formed round the edge of the wound. The orchards should be regularly inspected every winter and the necessary surgical treatment, exact details of which are given, carried out. Badly infected trees are both unsightly and unprofitable, and should be removed and burnt. There is no danger of infection to the new trees planted in their place.

Departmental Activities: Botany.—*Journ. Dept. of Agric. S. Africa*, v, 4, p. 306, 1922.

Apple branch blister, caused by *Coniothecium chomatosporum*, has been observed on a number of apple and pear twigs sent to the Department for examination. As a rule the branches are not seriously affected, but unless preventive measures are taken the fungus spreads to the fruit, causing cracking and russeting. On the twigs and branches numerous dark specks, generally in groups, are formed, and frequently reddish-brown, irregularly raised blisters develop. All affected twigs should be removed and destroyed, and a winter wash (1 lb. of copper sulphate to 25 gallons of water) applied before bud-bursting time. Spraying with Bordeaux mixture (4–4–50) before the flower-buds open and again soon after the blossoms fall is recommended, and this should be followed by a third application when the fruit is well set.

Pcttcrill (V. A.). **The biology of Schizophyllum commune Fries, with special reference to its parasitism.**—*Sci. Bull. Dept. of Agric. S. Africa*, xxv, 35 pp., 5 pl., 5 figs., 1922.

The occurrence of sporophores of *Schizophyllum commune* on living apricot trees in the Cape Province, and the fact that the wood was found to be permeated by its mycelium, led the author to investigate the parasitism, often assumed but never experimentally proved, of this fungus. He found *S. commune* occurring commonly on dead wood, and also apparently as a wound parasite on stone fruit and sometimes on apple trees. Sporophores were generally found on parts of the tree suffering from sun-scald, but also occurred scattered generally over quite unwounded branches. Injuries were generally found in such cases on some other part of the tree. The practice of slitting the bark to prevent a bark-bound condition, and the injuries inflicted on the roots in the process of cultivation, afford a possible means of entrance to the fungus, but probably the most common mode of infection is through areas in which the bark has been killed and where the healing process is protracted indefinitely, as in sun-scald cankers. The time

taken by the wounds to heal and the vigour of the trees are factors that influence infection to a certain extent, while a deficiency of lime in the soil, such as is characteristic of the Western Province where these observations were made, seems to increase the rate of growth of the fungus within the host.

The diseased wood was marked by dark, radiating streaks, but, though brittle, its hardness was not impaired and it was difficult to cut when dry. Hyphae were abundant except in the older areas of infection, where they seem to become disorganized and to disappear, as is known to occur in other similar cases. The vessels, wood fibres, and medullary rays were frequently blocked by gum, probably formed as a result of the traumatic stimulus given by the growing parasite to the living cells of the wood, which secrete the gum into the fibres and vessels. In its action on the cell walls *S. commune* attacks primarily the cellulose, and does not cause delignification. Starch is absent from the cells of the invaded tissues. The mycelium, when grown in pure culture in a liquid medium, produced cytase, diastase, emulsin, invertase, maltase, and lipase. It did not produce peroxidase, gum-hydrolyzing, or delignifying enzymes.

The fungus was readily isolated from diseased wood, and grew vigorously on a large number of media, the cultures being described in detail. On media favouring growth the mycelium is at first white and cottony, but later becomes more compact, and finally felty, taking on a pink-buff colour; on others, as for instance potato agar, growth is slow, there is little aerial mycelium, and the latter is almost colourless. Sporophores, which are produced in the light on a number of media in about 20 days, do not develop in darkness although mycelial strands and foliar outgrowths, probably representing abortive fructifications, are formed. The hymenium faces downwards whatever the direction of the surface of the medium, and positive heliotropism was observed in the sporophores in one of the experiments. In a comparison made between isolations from a parasitic and a saprophytic strain of *S. commune*, the author found sporophore formation much less marked in the latter than in the former. Pure cultures, completely dried out, remain viable for at least two years. Indications were found that wounding the mycelium had a stimulating effect on sporophore production.

Spores from a fresh spore-print germinated readily in a nutrient solution, but very feebly in distilled water. When fresh spores were treated with 1 : 1000 copper sulphate solution for 7·5 minutes germination was reduced by about 50 per cent., and it was almost completely inhibited when the solution was strengthened to 1 : 500. After twelve days, spores sown in nutrient solutions gave little or no germination, but they germinated vigorously again as soon as copper sulphate, diluted to 1 : 5000 and 1 : 7000, was added, germination being even better than that of fresh spores in a nutrient medium alone.

Inoculation experiments carried out at Pretoria are fully described. These proved that *S. commune* is able to grow in living wood, which it kills, when inoculated through wounds. Of sixteen inoculations on stone-fruit trees, twelve were successful, while four made on the roots, green shoots, and stems of young almond trees

were not conclusive. In every instance the fungus was recovered from the discoloured wood, but a sporophore was only once produced. Growth within the wood was slow under the conditions of the experiments, reaching only about eight inches from the point of inoculation after two years and four months. The author concludes that though the harmful effects of this fungus may not be immediately apparent, the total damage caused by it must be very considerable owing to the insidiousness of its action and the wideness of its distribution.

OSTERWALDER (A.). **Phacidiella discolor (Mont. & Sacc.) A. Poteb. als Fäulnispilz beim Kernobst.** [*Phacidiella discolor* (Mont. & Sacc.) A. Poteb. as a rot-producing fungus in core fruit.]—*Landw. Jahrb. der Schweiz*, xxxvi, 6, pp. 852–853, 1922.

During the winter of 1919–20 stored apples and pears were attacked by a black rot which differed in various respects from that caused by *Sclerotinia fructigena*. The causal organism was isolated and identified as *Phacidiella discolor*, and inoculation experiments on different varieties of apples and pears produced the typical symptoms of the rot, which include the formation on the skin of small, oval spots and the development of a leathery consistency in the fruit. This is believed to be the first occasion on which the fungus was observed on Swiss fruit.

WATERS (R.). **Fireblight.**—*New Zealand Journ. of Agric.*, xxiv, 6, pp. 350–357, and xxv, 4, pp. 209–214, 9 figs., 1922.

Fireblight (*Bacillus amylovorus*) has spread continuously since first reported in New Zealand [see this *Review*, i, p. 22], but is still confined to the North Island. The stone fruits, mountain-ash (*Sorbus*), juneberry (*Amelanchier*), and *Pyrus japonica*, all of which are occasionally attacked in North America, have not so far shown signs of the disease in New Zealand. Pears are the most seriously affected fruit trees, and with them the problem of control is more complicated than in the case of apples. With the latter the chief difficulty is the liability of reinfection from diseased hawthorn, which is extensively used for hedges in fruit-growing areas. The eradication of hawthorn from these districts is an essential factor in the control of the disease.

The symptoms of the disease and characters of the causal organism are described. Field experiments have shown that the effects of blossom inoculation may not immediately be manifested, but they become apparent in the blackening of the calyx-cup when the young fruits begin to form. Initial infection very commonly takes place on the blossoms, and in some districts the disease is known as 'blossom blight'. The discoloration may extend from the immature fruit through the stalk to the spurs or twigs, while any soft growth is liable to infection through the punctures of sucking or biting insects. The disease progresses more rapidly in pears than in apples, having been known to kill large trees outright in a single season. The young bark of apple trees is more easily penetrated than the tougher bark of old trees.

The formation of cankers and the overwintering of the bacilli in the so-called hold-over cankers are discussed, and it is pointed out

that while excision of such cankers is naturally a most important method of control, the difficulties connected with this operation in New Zealand appear almost insuperable, chiefly in view of the fact that the organism has been shown to be capable of wintering over in hawthorn cankers as well as in those of fruit trees.

Direct sunlight has been proved to have a very destructive effect on the bacilli, which begin to succumb to the action of the rays in less than an hour. They can withstand ordinary desiccation, as in thin, dry films of water-diluted ooze, for about eight days. Furthermore, all strains are not equally pathogenic, and temperature has an influence on successful infection.

On the whole, the author does not consider that the organism is likely to possess the power of surviving in an actively infective condition when transported over long distances by natural agencies. On the other hand, he has found that the bacilli can live for nine months in pure water without entirely losing their power of infection. Fireblight can only have been introduced into New Zealand, and carried over the long distances to which it has spread within the confines of that country, by human agency. Every precaution must be taken to ensure, firstly, that the disease shall not cross Cook Strait, and, secondly, that it is confined within the notified boundaries to infected areas. The legislative measures taken with a view to defining the infected areas and securing treatment within these areas are mentioned [see this *Review*, ii, p. 144], but legislation must be supported by the co-operation of the people if fireblight is to be prevented from reaching all parts of the country.

The only satisfactory method of controlling fireblight is the complete removal, well before the blossoming period, of all diseased portions of the affected tree. The wounds made by cutting and scraping should be disinfected by swabbing with a 5 per cent. solution of formalin or lysol, or one part each of cyanide of mercury and bichloride of mercury to 1,000 parts of water. After sterilization, the wound should be painted with a mixture of creosote and tar, or with white lead paint, preferably the former. The sterilization of all implements in one of the above-mentioned disinfectants is also essential.

JACKSON (H. S.). **Pear blight control is feasible.**—*Amer. Fruit Grower*, xlii, 8, pp. 3, 27, and 29, 1 fig., 1922.

The solution now most commonly recommended for the disinfection of the wounds caused by the excision of the cankers of pear blight [*Bacillus amylovorus*] is one part of corrosive sublimate and one part of cyanide of mercury to five hundred parts of water. The solution must not be kept in metal containers, but should be carried in a bottle and applied with a sponge. It may also be used for the sterilization of the tools.

It is now becoming generally known that the following varieties of pears, in addition to the Kieffer [see this *Review*, ii, p. 125], are resistant in the southern States: Garber, Tyson, Seckel, and Koonce. The so-called Japanese seedling, *Pyrus serotina*, has come into general use as a root stock, and for the same purpose the highly resistant *P. ussuriensis* may be used, while a very promising

Chinese species is *P. calleryana*. These desirable foreign varieties, however, are available only in limited quantities as yet and will probably have to be grown on a larger scale in the United States.

OSTERWALDER (A.). **Versuche zur Bekämpfung de Weissfleckenkrankheit der Birnbäume und Blattbräune der Quitten.** [Experiments in the control of white spot disease of Pear trees and brown leaf of Quinces.]—*Landw. Jahrb. der Schweiz*, xxxvi, 6, pp. 839–841, 1922.

White spot disease of pear trees [*Mycosphaerella sentina*], which is greatly on the increase in Switzerland and attacks a number of well-known commercial varieties, can be satisfactorily controlled by two applications of 1·5 to 2 per cent. Bordeaux mixture, the first given during the latter half of May and the second two or three weeks later.

Similar treatment was also found effective in the control of *Entomopeziza sorauerì* Kleb. [*Fabraea maculata* (Lév.) Atk., *Entomosporium maculatum* (Lév.)], which has caused severe damage to quinces during recent years.

CUNNINGHAM (G. H.). **The significance of apothecia in the control of brown-rot of stone-fruits.**—*New Zealand Journ. of Agric.*, xxv, 4, pp. 225–230, 1 fig., 1922.

The apothecial stage of *Sclerotinia cinerea* was found for the first time in New Zealand in 1922. Between the 11th and 30th September numerous specimens were obtained on mummied peaches and nectarines. The trees were in blossom the whole of this period, blossom infection first becoming noticeable on 30th September. On 15th September plum mummies in an orchard near Christchurch also developed apothecia. Blossom infection was observed in this case on 29th September. Some of the mummies were those of the preceding season's fruit, while others appeared to be more than one season old.

Details of the structure of the mummies and apothecia are given, the microscopic characters of the latter being stated to agree in most respects with the descriptions of the European form.

On 15th September ascospores were isolated and inoculated into apple fruits, half of which were rotted at the end of ten days. No conidia appeared on the surface until eighteen days later, the fruits meanwhile turning dark and assuming the characteristic appearance of brown rot.

Showery weather, accompanied by warm days and cold nights, appears to favour the development of apothecia. Their number decreased with the depth in the soil at which the mummies were buried. At a depth of 3 in. only one apothecium was produced, so that a depth of soil exceeding this amount may be regarded as a directly inhibiting factor. All the specimens were found in hard and compacted soil, these conditions seeming to be essential to their production; recently cultivated soil did not yield any apothecia.

In addition to the treatment by spraying already advised [see this *Review*, ii, p. 165], the removal, during pruning operations, of all mummies, cankered limbs, and sickly laterals, which should be

burnt whenever possible, is recommended, and also cultivation of the soil after pruning but before blossoming, compacted soil being broken by hand if necessary.

HAMMOND (A. A.). **Spraying experiments for brown rot of stone fruit (Sclerotinia fructigena).**—*Journ. Agric. Victoria*, XX, 3, pp. 182–189, 1922.

The following preparations were used against *Sclerotinia fructigena* in a series of comparative experiments on plum, peach, and cherry trees in an orchard at Seville, Australia. (1) Bordeaux mixture used at a strength of 12–8–80 for pre-blooming, and of 3–9–50, 3–3–50, and 3–3–40 for late sprayings. (2) Woburn Bordeaux, i.e. 13·75 galls. clear lime water, and 1 lb. bluestone, made up to 80 galls. with fresh water. (3) Acetate of copper 1 lb. to 13 galls. water for pre-blooming spray, and 10 oz. to 40 galls. and 15 oz. to 40 galls. for late sprays. (4) Home-boiled lime-sulphur, 26° Baumé (specific gravity 1·220), used 1 in 9 as a pre-blooming spray. (5) Self-boiled lime-sulphur 15–15–80 used as a late spray. (6) Sulphur sprays, including atomic sulphur, atomized sulphur, and home-made sulphur wash (casein, skimmed milk, and flour paste being used as spreaders in the last named). For cherries 1½ galls. of lime-sulphur (26° Baumé) were added to the home-made sulphur and skimmed milk wash, and for late spraying for peaches 1 gall. lime-sulphur was added. The home-made sulphur washes contained 10 lb. of dry sulphur to 80 galls. water, an average of 2·75 galls. being used per tree.

None of the spray mixtures caused any injury to fruit or foliage except Bordeaux mixture on peaches. No difference was observed in the efficacy of any of the sulphur sprays without lime, which have the advantage of being clean, safe, and suitable for use late in the season. They do not, however, adhere as well as lime-sulphur, and are therefore better adapted to hairy-skinned fruits, such as peaches and apricots, than to cherries or plums. Bordeaux mixture or boiled lime-sulphur may safely be used for the first spray for all stone fruits except apricots. Cherries should receive their first spraying when 10 per cent. of the blossoms are open, being very susceptible during flowering to the attacks of the fungus. The second application should be given immediately after the fruit sets. Peaches and plums do not appear to be liable to attack during blossoming. All kinds of fruit are apt to become infected about ripening time, and the final applications of the sprays should be given as late as possible consistent with clean fruit at harvesting. Copper acetate, besides being the most expensive of the preparations tested, was also the least effective. Exclusive of labour and fuel the approximate cost of 80 galls. of self-boiled lime-sulphur was 3 shillings, while the same quantity of copper acetate worked out at 7 to 9 shillings according to the strength used. Sulphur wash and casein (home-made) cost only 1s. 10*d.* per 80 galls., while atomic and atomized sulphur each cost 8s. 4*d.*

The writer believes that the control of the fungus by spraying in a wet season would be extremely difficult owing to the rapidity of fructification and spread. It should be attacked and eradicated in dry seasons unfavourable to its development.

MÜLLER-THURGAU (H.). **Weitere Beobachtungen über die Blattbräune der Kirschbäume.**—[Further observations on leaf scorch of Cherry trees.]—*Landw. Jahrb. der Schweiz*, xxxvi, 6, pp. 822–824, 1922.

Leaf scorch of cherry trees, caused by the fungus *Gnomonia erythrostoma*, varies considerably in prevalence and intensity according to the locality. Generally speaking, the disease is more severe in valleys than in elevated, sunny situations. Meteorological conditions during the spring, however, play an important part in the development of the fungus. The perithecia contained in the dead leaves which remain hanging on the tree all the winter require periodical showers for their development and for the liberation of the spores. Hence after a dry spring there may be only very slight infection compared with that resulting from wet weather during the growing season.

The symptoms of the disease are also very variable, ranging from the typical large, yellowish-brown spots to a reddish discoloration. The latter occurs when the fungus penetrates the petiole only, presumably through the glands, with the result that the sugar cannot pass through the petiole to the branch and therefore accumulates in the leaf. In such cases the leaves, not being directly attacked, are able to continue their functions for a time but gradually disturbances in metabolism arise which cannot be overcome.

It was observed in various cases that trees which had been severely injured in one year completely recovered in the next. Atmospheric conditions not being sufficient to account for the change, the matter was investigated with the result that *Gnomonia erythrostoma* was found to be attacked by *Trichothecium roseum*, which had completely destroyed the perithecia of the leaf scorch organism. Experiments are in progress to ascertain whether this valuable means of biological control can be utilized on a large scale.

OSTERWALDER (A.). **Ein Versuch zur Bekämpfung der durch Pseudopeziza ribis verursachten Blattfallkrankheit der Johannisbeersträucher.** [An experiment in the control of leaf fall disease of Currants caused by *Pseudopeziza ribis*.]—*Landw. Jahrb. der Schweiz*, xxxvi, 6, p. 833, 1922.

Excellent results were obtained in the treatment of this disease in 1918 by the application of 1·5 per cent. Bordeaux mixture to susceptible White Versailles currants. The sprayed bushes remained completely healthy and green until October, in striking contrast to the untreated controls, which lost their leaves at the beginning of September.

MANARESI (A.). **La 'Sphaerotheca mors-uvae' (Schw.) Berk. nell' Emilia.** [*Sphaerotheca mors-uvae* (Schw.) Berk. in Emilia.]—*Riv. Patol. Veg.*, xii, 7–8, pp. 83–84, 1922.

American gooseberry mildew (*Sphaerotheca mors-uvae*) was first observed in Italy in 1914, when it was found in the Pavia district. In 1920–21 it spread to the district of Novara and in 1922 Asti and Casale were reached. In July of the same year the author found the fungus on gooseberry and currant

bushes in Emilia, where they are cultivated chiefly for jam-making purposes. It is thought that the disease was introduced on plants imported from other regions of Italy two years previously. Although many bushes are affected it does not seem to cause as much damage as elsewhere. This is believed to be due to the energetic control measures carried out by growers, which consist of frequent pruning, and several sprayings with lime-sulphur or Bordeaux mixture (4 to 5 per cent.) during the resting period, followed by the application of more dilute solutions during the growing season.

Osterwalder (A.). **Versuche zur Bekämpfung der Didymellakrankheit an Himbeerruten mit Bordeaux- und Schwefelkalkbrühe.** [Experiments in the control of the *Didymella* disease of Raspberry canes with Bordeaux mixture and lime-sulphur.]—*Landw. Jahrb. der Schweiz*, xxxvi, 6, pp. 848–849, 1922.

No satisfactory method of controlling the die-back of raspberry canes due to *Didymella applanata* has yet been devised. The results of experiments at Wädenswil with copper sulphate, Bordeaux mixture, and lime-sulphur were all negative.

Weiss (C. O.). **Diseases and pests of Raspberries.**—*Better Fruit*, xvii. 6, pp. 7–8, 1922.

This article contains notes on the principal diseases of raspberries in the State of Washington. Crown gall [*Bacterium tumefaciens*], the symptoms of which are described, is increasing in severity every year, and can only be controlled by the use of absolutely pure stock for planting. Under Quarantine No. 6 of the Washington State Department of Agriculture it is a misdemeanour to take any plants from infected fields.

Mushroom rot (*Armillaria mellea*) causes considerable damage in the older fields, the plants being attacked at the crown and roots. The progress of the disease is slow, and several years may elapse before the actual death of the plants. The rhizomorphs of the fungus frequently grow through the soil from hill to hill along the row. The disease is most prevalent on newly cleared land, on which raspberries should not be planted for at least three years. Affected bushes should be burnt and the soil where each plant stood removed to a depth of two feet and a diameter of two to three feet. This hole should be refilled from some other part of the field where the disease does not occur.

Anthracnose (*Plectodiscella veneta*) [*Gloeosporium venetum*] has not yet caused such serious losses in the north-western as in the eastern districts, and may generally be controlled by cutting out the diseased canes. In severe cases, however, spraying should be carried out as follows: (1) before the opening of the buds, Bordeaux mixture 5–5–50 with 1 lb. of resin fish-oil or whale-oil soap; (2) a fortnight after flowering (when the fruit is about half grown) Burgundy mixture ($CuSO_4$ 2 lb., Sal soda 3 lb., water 100 gallons), also with the addition of the soap. Stock from infected fields should on no account be used.

Spur blight (*Mycosphaerella rubina*) is a common trouble on the

red raspberry, especially the Cuthbert and Antwerp varieties. The first symptom is the appearance of chocolate-coloured or purplish-brown areas on the young canes, usually just below a bud. In the winter the affected bark turns white and becomes shredded and loose. About mid-winter the spores of the fungus develop on the bark, in readiness to start the new infections in the spring. The disease may be controlled by three applications of Bordeaux mixture 2–3–50, plus 2 lb. of fish-oil soap, starting when the new shoots are 6 to 8 inches in height.

AGATI (J. A.). **Banana stem and fruit rot.**—*Philipp. Agric.*, x. 9. pp. 411–422, 1922.

From 1919 to 1921 investigations of the stem and fruit rot of bananas caused by *Gloeosporium musarum* were carried on at the Los Baños College of Agriculture, where some thirty varieties, mostly foreign, were attacked. Of the native varieties the sweet bananas were generally the most susceptible. About 15 per cent. of the bunches were infected. The fungus was found not only on unripe fruit but also on stored bananas, especially if the skin of the latter was bruised or moist. The infected fruit was sour in flavour and had a characteristic smell.

The earliest external symptom of the disease consists in the appearance of small, black, circular specks on the skin at the distal ends of the 'hands'. Similar spots may also develop on the flowers, and later on the stalk of the bunch becomes infected. The specks become sunken and merge into one another, thus forming larger spots, which, in severe cases, may cover the entire fruit. In these confluent, dead areas bright red groups of spores develop, at first moist, but later hardening and becoming dry. Infected fruits ripen prematurely, turn black, and decay. The stem becomes stunted and dry, and the leaves droop and shrivel.

Inoculation experiments with pure cultures were conducted both in the field and in the laboratory, and showed that the fungus readily attacked wounded fruit, but the incubation period differed according to the variety of banana tested. In susceptible kinds it was usually 6 to 11 days, whereas in the more resistant varieties symptoms did not appear in some cases until after 24 days. In needle-prick inoculations a longitudinal black streak develops from the wound, and the surrounding areas become watery. Immature fruits, especially when on the bunch with the inflorescences still attached, were found to take the disease more readily than mature fruit from which the inflorescence had fallen. Humidity favours infection. Natural infection may take place through the wounds caused by cutting the bunches.

The morphological characters of the fungus are described. In form, structure, and colour the spores corresponded closely with the description given in text-books, but they measured 13·5 to 15·5 by 5·5 to 7·5 μ instead of 10 to 12 by 4 μ, as previously stated. There were slight differences in the growth of the fungus on the various media used, but the spores and mycelium produced were microscopically identical in all cases. In cultures on the same medium the organisms isolated from different varieties of banana were indistinguishable.

The following precautionary measures are recommended. In the absence of facilities for immediate transport and consumption only resistant varieties, the names of several of which are given, should be planted. Resistant varieties should be spaced 3 by 3 metres apart, and susceptible varieties 4 by 4 metres. Resistant and susceptible varieties should not be interplanted. Sweet varieties should be planted, whenever possible, in separate fields, and the planting of the susceptible foreign sweet varieties should be discontinued. The fruit should be stored in a well ventilated room, the susceptible and resistant varieties being kept apart. In gathering, the rachis must not be cut close to the fruit, and the cuts should be smooth and clean. Great care must be taken not to bruise the fruit. Ants and other insects should be kept away from the fruit, as they may act as carriers of the spores. Spraying the fruit with Burgundy mixture is beneficial.

ORTON (W. A.) & MEIER (F. C.). **Diseases of Watermelons.** —*U.S. Dept. Agric. Farmers' Bull.* 1277, 31 pp., 21 figs., 1922.

A brief popular account of watermelon diseases in the south-eastern States is given, a description of the symptoms and appropriate measures of control being furnished in each case. Wilt (*Fusarium niveum*) necessitates strict attention to cultural measures, the most important of which is to keep infected soil free from watermelons for a period of ten or twelve years, or even longer. The use of organic manure should be avoided and care taken to prevent drainage water from infected fields reaching the crop. Resistant varieties, e. g. Conqueror, have been bred, but they are not recommended for general use at present.

Gummy stem blight (*Mycosphaerella citrullina*) is increasing in importance in the Middle West as well as in the south-eastern States, being particularly severe under conditions of abundant rainfall and high temperature. There are indications that the disease may be reduced by seed treatment, but its control has not been adequately studied. Ground rot (*Sclerotium rolfsii*), so called because it affects the side of the fruit next the ground, is the cause of considerable losses in Georgia, Florida, and South Carolina. It also attacks the roots and causes wilting and death of the whole plant. Seed treatment and crop rotation are recommended, but the latter is troublesome on account of the large number of hosts of the fungus. Anthracnose (*Colletotrichum lagenarium*) may be controlled by spraying the vines with Bordeaux mixture 4–4–50 and by seed treatment with 1 in 1,000 corrosive sublimate solution.

Stem-end rot (*Diplodia* sp.) [*D. tubericola*, see above, p. 256] has caused very serious losses in transit during recent years. Thorough field sanitation and stem-end disinfection with starch paste and copper sulphate are the best measures of control.

Minor diseases which are occasionally encountered include leaf spot (*Macrosporium* [*Cladosporium*] *cucumerinum*), bacterial wilt (*Bacillus tracheiphilus*), downy mildew (*Pseudoperonospora cubensis*), leaf spotting due to lack of potash, and blossom-end rot caused by the same *Diplodia* that produces stem-end rot, and also by other fungi.

DORAN (W. L.). **Laboratory studies of the toxicity of some sulphur fungicides.**—*New Hampshire Agric. Exper. Stat. Tech. Bull.* 19, pp. 3-11, 1922. [Abs. in *Exper. Stat. Record*, xlvii, 3, p. 243, 1922.]

Investigations were conducted to determine the conditions necessary for lime-sulphur solutions to exhibit a fungicidal action, since these solutions have been found to vary in their toxicity to apple scab (*Venturia inaequalis*) in New Hampshire. Different concentrations of lime-sulphur were sprayed on glass slides, allowed to dry for 24 hours, and then conidia of *V. inaequalis* suspended in distilled water were sown on the slides. On examination 24 hours later, it was found that the lime-sulphur had not prevented the germination of the spores.

It is stated that lime-sulphur, when dried on a tree, remains on the sprayed surface in the form of free sulphur, calcium thiosulphate, calcium sulphite, calcium sulphate, and calcium carbonate. The toxicity of calcium sulphate, calcium sulphite, sulphur, and precipitated sulphur was tested, and it was found that calcium polysulphide decomposed most rapidly and decreased in fungicidal efficiency when dried slowly. Sulphur was toxic only in the presence of oxygen, and its toxicity increased with rise of temperature and length of exposure. Precipitated sulphur proved more toxic to the conidia of *V. inaequalis* than finely ground sulphur, and acted at lower temperatures. Fungi were found to vary in their susceptibility to the toxic action of the sulphur.

Zur Saatgutbeizung. [On the disinfection of seed.]—*Nachrichtenbl. deutsch. Pflanzenschutzdienst*, ii, 10, p. 88, 1922.

According to a statement issued on September 13, 1922, by the Bavarian Ministry of Agriculture, the winter rye seed sown last autumn was attacked in an unusually severe degree by *Fusarium*. Samples examined by the National Institute for the Cultivation and Protection of Plants at Munich showed 80 to 90 per cent. of infection. The following fungicides are recommended for rye seed disinfections: fusariol (Fikentscher, Marktredwitz, Bavaria), germisan (Saccharinfabrik, Magdeburg), and uspulun (F. Bayer & Co., Leverkusen).

KASAI (M.). **Ueber den auf der Binse parasitisch lebenden Pilz Cercosporina juncicola sp. n.** [The fungus *Cercosporina juncicola* sp. n. parasitic on the Rush.]—*Ber. Ohara Inst. landw. Forschungen*, ii, 2, pp. 225-231, 3 pl. (1 col.), 1922.

The rush *Juncus effusus* var. *decipiens*, which is extensively cultivated in Japan for the manufacture of mats, has been attacked for at least the last twenty years by a stem spot disease. In the summer of 1921 the author visited one of the principal affected localities (Bingo, in the province of Hiroshima), and also examined a number of diseased specimens submitted to him. In the following summer the causal organism, which was constantly present on the affected stems, was identified as a species of *Cercosporina*.

The author states that the only allied fungus known on the rush is *Cercospora juncina* Sacc. from Ontario, but the species discussed in the present paper differs from this in the symptoms of the

disease which it causes, as well as in the structure of the conidiophores, dimensions of the conidia, &c. About twenty years ago, Hori found fructifications of a *Cercospora* on diseased rushes in Japan and proposed to name the fungus *C. junci*. This, however, he did not do, and as it is highly probable that Hori's fungus was identical with the present one, the author names the latter *Cercosporina juncicola* Hori & Kasai sp. n.

The disease, which is confined to half-grown plants, does not appreciably disturb their metabolism, since the mycelium does not extend far from the point of infection, and large portions of the stem, between the spots, remain quite green and healthy. Affected stems continue to grow without bending, and are normal in appearance except for the spots. The damage caused by the disease is noticeable chiefly in the finished product. The mats woven from diseased rushes are spotted and unsightly, and this greatly detracts from their commercial value.

The spots are irregularly distributed over the middle portion of the stem. At first they are extremely minute and invisible to the naked eye, but later they increase in size and become somewhat depressed owing to shrinkage of the affected tissues. They are very variable in shape, often confluent, whitish to ashy-grey in the centre, and surrounded by a dark-red or brown edge. The central portion, on which the conidiophores are borne, may measure up to about 7 by 3 mm.

The mycelium is ordinarily hyaline and profusely septate, but in places the hyphae often swell into brown, vesicular cells or groups of cells. This appears to represent a perennial mycelium, and a similar development is also found in pure cultures on rush decoction.

The conidiophores may be observed on almost all diseased plants. They are yellowish-grey in colour, and emerge from the stomata in expanding clusters. They are sometimes elongated, measuring 10 to 28 by 4 to 5 μ, somewhat thickened at the base, generally 1- or 2-, and occasionally 3-septate; and sometimes short and bulbous, only 4 to 6 by 4 μ, and non-septate. In very moist air much longer conidiophores, with numerous septa, are formed; the separate segments in this case often break off and resemble spores.

The conidia of the fungus, which are sparsely developed, and are extremely difficult to detect on dried specimens, are borne partly on the apex of the conidiophores and partly on sub-apical lateral protuberances. At first they are narrow, clavate, and non-septate, but later they become pointed and 3-septate, and are somewhat thickened at the basal end, where a button-shaped, rudimentary 'foot' also occurs. They are hyaline, or occasionally very pale green, and measure 23 to 48 by 2 to 3 μ. The length may increase to two or three times the normal in a humid atmosphere, but the breadth remains unaltered. They are very easily detached from the conidiophores, and germinate in a few hours in water. The germ-tubes penetrate through the stomata.

The best means of controlling the disease is to collect and burn all infected material at harvest time, and to use only healthy cuttings for propagation. If the cuttings have been exposed to infection, the stalks (but not the roots) may be immersed for a few minutes in Bordeaux mixture.

Ricerche e studi compiuti o in corso presso la R. Stazione di Patologia vegetale. [Research work and studies, completed or in progress, at the Royal Station of Plant Pathology.]—*Boll. mensile R. Staz. Pat. veg.*, iii, 10–12, pp. 120–124, 1922.

A brief account is given of further work by Peyronel on mycorrhiza. He has extended his investigations from cereals to a large number of cultivated and wild plants, particularly herbaceous ones; no list of these is given, however. He finds that in nearly all mycorrhiza-bearing roots two distinct mycelia are to be found, at least in the epidermal region. One of these resembles in its morphological characters some of the Phycomycetes, and is, he thinks, the more important of the two, judging from its development and behaviour in the radical tissues, but it has so far not been possible to grow it in culture. The other is a *Rhizoctonia* which he considers probably identical with *Rhizoctonia solani*, and perhaps also with a fungus which seems widespread in northern countries, especially Germany, where it is supposed to damage garden plants, and which is known by the name of 'Vermehrungspilz' (*Moniliopsis aderholdi* Ruhland). The *Rhizoctonia* in question has been isolated from many plants and grown in culture. On potato tubers it resembles typical *Rhizoctonia solani*; in culture its behaviour is the same as that of the endophytes of orchid roots, and like these it produces a quantity of *Monilia*-like conidia, such as described by Petri on the mycorrhizal mycelium of the vine and olive. *Asterocystis radicis* was found frequently on the roots of a number of herbaceous plants.

Besides these fungi, which Peyronel regards as probably truly mycorrhizal, inasmuch as no pathological effects are produced by their growth in the roots, several others were nearly always met with, especially in the older root-hairs and epidermis some distance from the growing apex. Particular mention is made of a *Fusarium*, a Hyphomycete not yet determined resembling *Didymopsis amnivora*, and a *Pythium*. Though probably only semi-parasitic, it is possible that these fungi may under favourable conditions penetrate into deeper tissues and do some damage.

From observations in the valleys of Piedmont, Peyronel considers that some ectotrophic mycorrhiza of trees, such as that found on *Larix decidua*, are represented by a *Rhizoctonia* identical with, or similar to the one already discussed. On *Alnus viridis* he has also found an ectotrophic mycorrhiza in addition to the characteristic tubercles. These he proposes to discuss in a future paper.

Demaree (J. B.). **Kernel spot of the Pecan and its cause.**—*U.S. Dept. Agric. Bull.*, 1102, 15 pp., 5 figs., 1922.

The kernel spot of pecan, a common disease in the southern States, was attributed by Rands to *Coniothyrium caryogenum*, and by Turner to insect punctures. The author carried on a series of experiments with two varieties of pecan encased in wire cages, in which the effect of southern stinkbugs (*Nezara viridula*) on the nuts was determined. The results of the tests led him to the conclusion that the pecan kernel spot is due to the action of the insect in mechanically rupturing the host cells, sucking the plant juices, injecting toxic substances into the tissues, or all three types of injury combined.

HASENÖHRL (R.) & ZELLNER (J.). **Chemische Beziehungen zwischen den höheren Pilzen und ihren Substraten.** [Chemical relations between the higher fungi and their substrata.]—*Monatshefte für Chemie*, xliii, pp. 21–41, 1922.

The water content of a fungus is generally higher than that of its host. K and PO_4 are the principal mineral constituents, Ca low, Na very low, except possibly in some coprophilous fungi, and Fe always present, though sometimes in very small quantities. The constitution of the substratum does not influence the composition of the ash in fleshy fungi. New ash analyses are given of the following: *Polystictus microloma*, *Polyporus fomentarius*, *P. laevalis*, and *Auricularia mesenterica*. In these K is lower and Ca higher than in fleshy forms. In *Trametes suaveolens*, *Polyporus igniarius*, and *P. fomentarius* $CaSO_4$ is specially high, while *Polystictus microloma* is very rich in NaCl.

A number of experiments were conducted to compare the osmotic pressure in different fungi and their hosts, and in almost every case the osmotic pressure of each soluble constituent present was higher in the fungus than in the host.

Experiments carried out with a view to detecting cellulose- or lignin-splitting enzymes in *Polyporus igniarius*, *P. hirsutus*, *Trametes suaveolens*, *Lenzites saepiaria*, and *Armillaria mellea* gave negative results. Analyses were made of a specimen of oak on which *P. igniarius* had been parasitic. The tree had lost 74 per cent. of its weight and the whole of its starch, sugar, and tannin. Otherwise its composition did not differ in the relative proportions of the different constituents of the cell membranes, &c., from that of the healthy oak, showing that the material of the oak was taken up equally by the fungus, without selective attack on any particular substance.

KENTISH WRIGHT (O.). **The action of yeast-growth stimulant.**—*Biochem. Journ.*, xvi, 1, pp. 137–142, 1922.

Wildiers' observation that certain yeasts can only grow at the expense of ammonium salts provided a heavy inoculation is employed, or a small quantity of organic material ('bios') added to the medium, has been confirmed by Williams and Bachman [1919]. These authors suggest that 'bios' is identical with the water-soluble *B* or anti-beri-beri vitamin, but the case for the identity of the two principles is not generally regarded as proven.

Lemon juice freed from citric acid added to a mineral nutrient solution in small quantities enables a yeast to grow which could not develop in its absence. The amount of water-soluble *B* vitamin in lemon juice being very small compared with that in yeast extract, an investigation was undertaken to ascertain its effects on the growth of yeast in mineral nutrient solutions.

A series of tubes was prepared containing the following solution with increasing percentages of lemon juice: saccharose, 20 gm.; $(NH_4)_2SO_4$, 3 gm.; KH_2PO_4, 2 gm.; $CaCl_2$, 0·25 gm.; $MgSO_4$, 0·25 gm.; and distilled water 1,000 cc. A similar series of tubes was prepared omitting the $(NH_4)_2SO_4$. The yeast employed was a pure culture of a baker's yeast. It was found that no growth took place in the mineral nutrient solution unless 5 per cent. or more of lemon juice

was added. The rate of growth was more or less directly proportional to the amount of lemon juice used, up to about 15 per cent. After the yeast reached a concentration of five or six million cells per cc. it was able to continue growing freely in the $(NH_4)_2SO_4$ tubes without the appearance of involution forms and with no film formation. When the concentration had not reached this point after six days, involution forms began to appear in the $(NH_4)_2SO_4$ tubes and by the ninth day a heavy film was produced. Apparently after six or seven days the cells in smaller concentrations than five or six million per cc. are able to adapt themselves to the use of $(NH_4)_2SO_4$ but only so that film formation results.

Another series of tubes was prepared with increasing percentages of aqueous yeast extract instead of lemon juice. It was found that the yeast extract was about ten times as effective as lemon juice in promoting growth, although its nitrogen content is more than thirty times as great. The yeast experiment confirmed the previous one in showing that the rate of growth is independent of the presence of $(NH_4)_2SO_4$ during the early period of the cultures and depends on the concentration of the 'bios' until the yeast has reached a concentration of about five or six million cells per cc., after which it proceeds further in the presence of $(NH_4)_2SO_4$.

Before proceeding to investigate the general question of vitamins by studying the biological processes in a yeast on these lines, it is necessary to be satisfied that 'bios' is actually a vitamin. The present investigation, however, suggests that 'bios' does not enable the yeast to assimilate $(NH_4)_2SO_4$ simply by its presence, or by being consumed simultaneously, but merely that the yeast grows solely at the expense of the 'bios' until it reaches a certain degree of concentration, after which it is able to use the $(NH_4)_2SO_4$.

ATANASOFF (D.). **Stipple-streak disease of Potato.**—*Meded. Landbouwhoogeschool, Wageningen*, xxiv, 5, 32 pp., 5 pl., 1922. [Dutch summary.]

Stipple-streak disease of potatoes, which occurred very severely in Holland in 1921, especially on the early variety Schotsche Muis (Victory), is allied to the degeneration or 'running out' group of diseases, which includes leaf roll, mosaic, and crinkle. The distribution of the disease is very general in Western Europe and North America, and a number of important commercial varieties are affected, including Green Mountain, Ninetyfold, President, Ashleaf, and Irish Cobbler. In the author's opinion, detailed grounds for which are given in a separate publication ['A study into the literature on stipple-streak and related diseases of potato.'—*Meded. Landbouwhoogeschool, Wageningen*, xxvi, 1, 1922], the older references to potato 'leaf curl', 'Krul-' or 'Kroesziekte', 'Krause-' or 'Kräuselkrankheit', 'Frisolée', and 'Pirve' in various European countries, all mean the disease described in the present paper, whereas of recent years these names have been indiscriminately applied to other diseases such as leaf roll, mosaic, and the like. With stipple-streak the author also identifies Sorauer's 'Stippelfleckenkrankheit', Horne's 'Leaf blotch', Miss Dale's 'Blindness', Orton's 'Streak', Appel's 'Schwarzflecken- und Streifenkrankheit', Güssow's 'Leaf-streak', and Murphy's 'Leaf drop', while Appel's Bakterienring-

krankheit was a combination of this and a bacterial soft rot of the tubers. The Dutch name 'Stippel-streepziekte' was first suggested by Quanjer, and the author advocates the use of this name in Dutch, of 'Streak' or 'Stipple-streak' in English, and of 'Schwarzflecken- und Streifenkrankheit' in German. He thinks the French may accept the English name.

During the 1921 epidemic in Holland a few of the potato crops were affected to the extent of 75 per cent., while 20 per cent. of infection was fairly common. In its primary form, stipple-streak is an easily recognizable disease, but secondary stipple-streak plants, i.e. those that arise from the tubers of primarily diseased plants, are often almost indistinguishable from those infected with crinkle or mosaic.

The first symptom of primary stipple-streak, which is most marked on early, succulent, and light green varieties, is the development of dark brown spots between the veins of the lower or middle leaves of the plant. The spots have a distinctly angular outline, the number of angles varying from three to five (usually the latter) or more. The spots are generally less than 0·5 cm. in diameter, uniform in colour and texture, and slightly depressed. In warm weather this preliminary symptom is succeeded by the appearance of black spots near the veins of the young leaves, just below the growing point. These spots are elongated, small, and very numerous. At this stage there is already a suggestion of mottling, and the affected plants somewhat resemble those attacked by mosaic disease. Dark, olivaceous-green to brown stripes are found on one or more sides of the stem. Sometimes the affected side of the stem and the spotted leaves on it are completely destroyed, while the opposite side continues to grow, causing a bending of the whole shoot to the diseased side. These stripes represent groups of dead or severely diseased cells and tissues, beneath the still normal epidermis and sub-epidermal layer. Their borders are not clearly defined and they have a water soaked appearance. Both stems and leaves begin to wilt from the top downwards. The disease usually spreads to all the shoots within two or three weeks, killing the plant. The first cases in Holland were observed in May, but the disease continued to appear throughout the growing season.

Affected tubers show on the surface distinct, slightly elevated blisters on and near the eyes and at the stem end. The blisters soon shrink and leave only dark brown or cinnamon-coloured spots. When they appear on young tubers, the cork layer and cortex split in various directions. The tubers of infected plants, even those which appear quite healthy at harvest time, may become blistered and discoloured in storage. Internally affected tubers can be recognized by their uneven and granular surface and by the deep-lying, brown blotches visible through the periderm. Sometimes the eyes of the tubers are completely and permanently destroyed.

When infected tubers are planted out they either fail to develop or produce stunted plants with small, crinkled leaves and short petioles. This is the secondary type of the disease. The leaves are slightly mottled and show the typical symptoms of stipple-streak described above, the brown spots, however, being less numerous

than in the primary form. The stems are covered with brown stripes and are split crosswise. The whole plant is extremely brittle, and the lower leaves fall, till at length only a few are left at the top. The plants generally die during the first month after their appearance. New sprouts may be formed once or twice after this, but they pass through the same phases as the first ones. The seed tuber usually persists without rotting, and one or more small, new tubers, discoloured and covered with blisters and splits, may also be found. They seldom sprout if planted, and when they do it is only to produce diseased shoots which die without bearing tubers.

In its secondary form stipple-streak differs from mosaic, crinkle, and leaf roll mainly in its severity, accomplishing in two or at most three generations from the first attack what the others achieve after a much longer period. It most closely resembles crinkle, but can usually be distinguished by a careful comparison of the symptoms, the differences being set out by the author in tabular form. It is also rather like a still undescribed disease, for which Quanjer has proposed the name leaf-drop-streak, except that there is no spotting of the leaves in the latter. Like other 'running-out' diseases, stipple-streak is systemic, spreading into all the shoots produced by the same tuber.

The pathogen of the disease, no suggestions regarding the nature of which are given, does not leave the plant under ordinary conditions and very likely dies with it. Healthy Schotsche Muis tubers stored in a damp cellar with 95 per cent. of heavily infected tubers of the same variety gave absolutely healthy plants. In another case healthy and diseased tubers were planted side by side in the same pot, with the result that the former gave healthy plants and the latter diseased ones. These and other experiments prove conclusively that the pathogen cannot pass from plant to plant through the soil, water, or air. Attempts to infect healthy plants with the sap from diseased ones also gave negative results. By establishing an organic connexion between a healthy and a diseased plant, however, it was possible to transmit the infection. This was done in two ways: by joining the cut surface of healthy tubers with that of infected ones so that an organic union was formed, and by grafting infected plants on healthy ones. In this respect also stipple-streak resembles leaf-roll, mosaic, and crinkle. Field observations indicate that natural spread of the disease from plant to plant occurs, but the manner of this is not known though insect transmission is evidently suspected. Temperature has a marked effect on the appearance and development of stipple-streak. Experiments showed that a temperature between 5° and 10° C. retarded the development of the disease and enabled the plants to make a normal growth without, however, destroying the source of infection, as the disease reappeared when they were again placed in a hot-house. Higher temperatures accelerated the progress of the infection.

Experiments in the treatment of infected tubers with 2 per cent. copper sulphate for one and two hours and 2 per cent. mercuric chloride for half an hour and one hour gave absolutely negative results. Tubers heated in dry air at a temperature of 44°

to 46° C. for 5, 15, and 24 hours also gave secondary stipple-streak plants in all cases. It is evidently impossible to destroy the pathogen of stipple-streak in the tubers without injuring the latter. It seems highly probable, however, that the disease can be controlled by the elimination of infected tubers and young plants, and this can be much more readily effected than in the case of the other running-out diseases, since the yield of tubers from infected plants is negligible in the second generation from infection.

DUBOYS. **La lutte contre la 'dégénérescence' des Pommes de terre dans l'Ouest de la France.** [The campaign against 'degeneration' of Potatoes in the west of France.]—*Rev. de Bot. appliquée*, ii, 14, pp. 586–589, 1922.

None of the potato varieties cultivated in Brittany, the chief centre of seed potato cultivation in France, is immune from leaf roll and mosaic, though the early varieties grown along the coast appear to be relatively less subject to these diseases. The selected early varieties Fluke (Géante de St.-Malo) and Fin-de-Siècle (Up-to Date) show a very low percentage of attack, apparently on account of the scrupulous care on the part of the local growers in the choice of their seed. Any plants deviating at all from the normal type in stature, shape of the leaves, colour of the flowers, and the like, are discarded. The practice of 'greening' and sprouting in trays exposed to air and light has also the advantage of enabling the growers to discard any seed tubers with abnormal (spindly) sprouts.

Unfortunately the late-maturing varieties grown inland do not receive the same attention, and the yield obtained from them is correspondingly lower. L'Institut de Beauvais is almost everywhere attacked by leaf roll, only one or two isolated plots in the north-east of Mayenne and the west of Sarthe being found free from it. The Saucisse (Rouge Plate) suffers much more from mosaic and leaf roll in Mayenne, Sarthe, and Vienne than in Brittany.

L'Industrie is also very subject to these diseases, except in Morbihan, where there is a sufficiency of healthy material to allow of selection in order to obtain a regular supply of disease-free seed. Early Rose and Chardonne, cultivated in the Côtes-du-Nord mainly for export, are other varieties mentioned as equally liable to leaf roll and mosaic.

The author again insists on the importance of systematic selection of the seed crop, and outlines a scheme for the establishment in every department of special 'selection fields' for the use of growers, accompanied by the distribution of awards and certificates for healthy seed.